The
Electrochemical
Society • • •

103rd Meeting

NEW YORK
April 12th-16th, 1953

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The Electrochemical Society
One Hundred and Third Meeting

Sunday through Thursday
April 12, 13, 14, 15, and 16, 1953

CONDENSED TECHNICAL PROGRAM

Electric Insulation (Abstracts 1-9)
Wednesday morning, April 15—9:00 A.M.-12:30 P.M. (Penn Top, North)
Wednesday afternoon, April 15—2:00 P.M.-4:30 P.M. (Penn Top, North)

Electronics—Luminescence (Abstracts 10-29)
Monday morning, April 13—9:15 A.M.-12:15 P.M. (Penn Top, South)
Monday afternoon, April 13—2:00 P.M.-4:30 P.M. (Penn Top, South)
Tuesday morning, April 14—9:30 A.M.-12:30 P.M. (Penn Top, South)
Tuesday afternoon, April 14—2:00 P.M.-5:00 P.M.—Round-Table Discussion (Penn Top, South)

Electronics—Rare Metals (Abstracts 30-38)
Thursday morning, April 16—9:30 A.M.-12:00 M. (Keystone Room)
Thursday afternoon, April 16—2:00 P.M.-4:00 P.M. (Keystone Room)

Electronics—Phosphor Screen Application (Abstracts 39-48)
Wednesday morning, April 15—9:00 A.M.-12:00 M. (Keystone Room)
Wednesday afternoon, April 15—2:15 P.M.-4:00 P.M.—Round-Table Discussion (Keystone Room)

Electronics—Semiconductors (Abstracts 49-61)
Tuesday afternoon, April 14—2:00 P.M.-5:00 P.M. (Penn Top, North)
Wednesday morning, April 15—9:30 A.M.-12:00 M. (Penn Top, South)
Wednesday afternoon, April 15—2:00 P.M.-4:00 P.M. (Penn Top, South)

Electro-Organic Chemistry (Abstracts 62-76)
Tuesday morning, April 14—9:00 A.M.-11:30 A.M. (Keystone Room)

Tuesday afternoon, April 14—2:15 P.M.-5:00 P.M.
(Keystone Room)
Wednesday morning, April 15—9:00 A.M.-12:00 M.—
Round-Table Discussion (Penn Top, Center)

Electrothermics (Abstracts 77-91)

Monday morning, April 13—9:30 A.M.-12:00 M.
(Penn Top, North)
Monday afternoon, April 13—2:00 P.M.-5:00 P.M.
(Penn Top, North)
Tuesday morning, April 14—9:30 A.M.-11:30 A.M.
(Penn Top, North)

Theoretical Electrochemistry — Symposium on Application of Electrochemistry to Biology and Medicine (Abstracts 92-116)

Monday morning, April 13—9:15 A.M.-12:15 P.M.
(Sky Top)
Monday afternoon, April 13—2:00 P.M.-5:00 P.M.
(Sky Top)
Tuesday morning, April 14—9:00 A.M.-12:00 M.
(Sky Top)
Tuesday afternoon, April 14—1:45 P.M.-4:45-P.M.
(Sky Top)
Wednesday morning, April 15—9:00 A.M.-12:15 P.M.
(Sky Top)
Wednesday afternoon, April 15—1:45 P.M.-4:15 P.M.
(Sky Top)

Theoretical Electrochemistry—General (Abstracts 117-135)

Monday afternoon, April 13—2:00 P.M.-4:45 P.M.
(Penn Top, Center)
Thursday morning, April 16—9:00 A.M.-11:55 A.M.
(Sky Top)
Thursday afternoon, April 16—2:00 P.M.-4:30 P.M.
(Sky Top)

GENERAL INFORMATION

Convention Headquarters will be at the **Hotel Statler,** Seventh Avenue and 33rd Street, New York, N. Y.

Rates for rooms will be: single room $5.50 to $10.00; double bedroom $8.00 to $12.50; twin bedroom $9.50 to $17.00; parlor suite $23.00 to $25.00.

Requests for room reservations should be made to Front Office Manager, Hotel Statler, with mention of The Electrochemical Society.

REGISTRATION

The registration desk, located on the south side of the mezzanine floor, will be open Sunday, April 12, from 4:00 P.M. to 10:00 P.M.; Monday, April 13, from 8:00 A.M. to 5:00 P.M.; and Tuesday, Wednesday, and Thursday from 9:00 A.M. to 5:00 P.M. On Thursday, April 16, the registration desk will be in the Keystone Foyer.

Registration fees are:

Members	$7.00	Students	$ 2.00
Ladies	$3.00	Nonmembers	$10.00

If a nonmember fills out an application blank and is subsequently elected, the difference between the nonmember and member registration fee will be applied to his first year's dues.

INFORMATION ABOUT NEW YORK

An information desk will be set up in the registration area, at which it will be possible to obtain detailed information about New York City. Advice will be available on restaurants, eating places, night clubs, museums, shopping, concerts, entertainment, and all other activities.

ROUND-TABLE DISCUSSIONS AND SPECIAL SYMPOSIUM

Three round-table discussions are scheduled: one by the Luminescence Section of the Electronics Division for 2:15 P.M., Tuesday, April 14; one by the Phosphor Screen Application Section of the Electronics Division for 2:00 P.M., Wednesday, April 15; and one by the Electro-Organic Chemistry Division for 9:00 A.M., Wednesday, April 15.

The Theoretical Electrochemistry Division has scheduled six sessions to be devoted to a Symposium on Application of Electrochemistry to Biology and Medicine. These six sessions will be held on Monday, Tuesday, and Wednesday, April 13, 14, and 15.

RICHARDS MEMORIAL LECTURE

Dr. William Shockley of the Bell Telephone Laboratories will deliver the Richards Memorial Lecture at 4:00 P.M. on Wednesday, April 15, in the Penn Top, South. He will talk on "Transistor Physics."

LUNCHEONS AND DINNERS

Monday Luncheon and Annual Business Meeting

The general Society luncheon will be held Monday, April 13, at 12:30 P.M. in the Keystone Room. Dr. John R. Dunning, Dean, School of Engineering, Columbia University, will speak on the subject "Engineering Comes of Age." Immediately following the luncheon, the annual business meeting will be held.

Monday Cocktail Party and Dinner

There will be a Society dinner Monday evening at 7:00 P.M. in the Penn Top, South, at which the featured speaker will be from the Symposium on the Application of Electrochemistry to Biology and Medicine. The dinner will be preceded by cocktails at 6:15 P.M. in the Penn Top, Center.

Tuesday Evening Reception and Banquet

A reception for President and Mrs. J. C. Warner will be held Tuesday, April 14, at 6:15 P.M. in the Sky Top. Following this, the banquet of the Society will be served in the Penn Top, South, and President Warner will deliver the presidential address. There will be dancing until 12:30 A.M.

PLANT TRIPS

Owing to security restrictions and to transportation difficulties in the Metropolitan area no formal plant trips have been organized for this meeting. However, if individuals or small groups desire to visit a specific plant, G. A. Lux, Chairman of the Plant Trip Committee, should be consulted at the registration desk, and every effort will be made to make arrangements for such visits.

LADIES' PROGRAM

Conference Room 3 has been set aside as a Ladies' Headquarters Room for the duration of the convention. This room is on the mezzanine floor in the vicinity of the registration area. It will be a place to gather and discuss plans.

Monday luncheon—The ladies are invited to attend the Society luncheon in the Keystone Room at 12:30 P.M. ($3.00).

Monday afternoon—Immediately following the luncheon there will be a Ladies-Get-Together in the Keystone Foyer.

Tuesday morning—Bus tour of up-town New York, leaving Hotel Statler at 9:45 A.M. (Complimentary).

Tuesday luncheon—A luncheon will be served in the Washington Square Room of the Fifth Avenue Hotel (at 9th Street) at approximately 12:15 P.M. (Complimentary).

Tuesday afternoon—Bus tour of down-town New York, including Chinatown, leaving from the Fifth Avenue Hotel and returning to the Statler, 1:45-4:30 P.M. (Complimentary).

Tuesday evening—Reception, banquet, and dancing, 6:15 P.M. ($12.50 a couple).

Wednesday and Thursday—During the rest of the convention the Ladies' Committee will conduct escorted trips for small groups to anywhere in New York they desire to go. Some of the more likely trips will be planned in detail and tickets may be required. Others may be arranged on the spur of the moment. The planned trips will probably include the United Nations, Radio City, the Metropolitan Museum, Hayden Planetarium, the Empire State Building, and a fashion show. Full use should be made of the Ladies' Headquarters in Conference Room 3 in arranging these activities.

Tickets to some TV and radio broadcasting studios will be available during the convention.

A Theater Ticket Reservation sheet has been mailed to members to aid in advance purchase of theater tickets.

LUNCHEONS AND BUSINESS MEETINGS OF DIVISIONS

Electronics Division—will hold a luncheon and business meeting on Tuesday, April 14, at 12:30 P.M. in the Keystone Room.

Electrothermic Division—will hold a luncheon on Tuesday, April 14, at 12:30 P.M. in Parlor B.

Electric Insulation Division — will hold a luncheon and business meeting on Wednesday, April 15, at 12:30 P.M. in the Keystone Room. The luncheon will be in honor of Professor Peter Debye, who will speak on the subject "The Electrical Interpretation of Molecular Forces."

Electro-Organic Division—will hold a luncheon on Wednesday, April 15, at 12:30 P.M. in Parlor 1.

Theoretical Electrochemistry Division — will hold a business meeting on Thursday, April 16, at 11:55 A.M. in the Sky Top.

BOARD AND COMMITTEE MEETINGS

Sunday, 10:00 A.M.—Meeting of the Ways and Means Committee in Conference Room 7.

Sunday, 2:00 P.M.—Meeting of the Board of Directors in Conference Room. 7.

Monday, 5:00 P.M.—Meeting of the Editorial Staff in Conference Room 7.

Tuesday, 5:00 P.M.—Meeting of the Local Section Advisory Committee in Conference Room 7.

Wednesday, 2:00 P.M.—Meeting of the Membership Committee in Conference Room 7.

Wednesday, 5:00 P.M.—Meeting of the Sustaining Membership Committee in Conference Room 7.

Conference Room 7 is available for committee meetings Monday through Thursday. Any committee desiring to utilize this space should make a reservation at the registration desk.

Social Hour

The Luminescence Section of the Electronics Division will hold a social hour on Monday, April 13, from 4:30 to 6:00 P.M. Admittance will be by ticket only. In Penn Top, South.

COST OF VARIOUS FUNCTIONS
(other than registration)

Division Luncheons	$ 3.00
Monday Society Luncheon	$ 3.00
Monday Dinner	$ 6.00
Tuesday Reception and Banquet, Dancing	
(single)	$ 7.50
(couple)	$12.50

JOURNALS

Copies of the January, February, March, and April issues of the JOURNAL of The Electrochemical Society containing some of the papers presented will be available at the registration desk. The price of single copies of the JOURNAL is $1.25 to members and $1.50 to nonmembers.

EXTENDED ABSTRACTS

The Electronics Division is making available again an extended abstract booklet containing 1000-word abstracts of most of the papers pre-

sented at the Division's New York symposia. Copies of the booklet will be on sale at the registration desk for $1.50 each.

DISCUSSION

There will be no recordings made of oral discussions. Those contributing to the discussion of a paper and desiring their remarks published will be supplied with a printed form on which any discussion may be written. These forms should be given to the Secretary-Treasurer of the Division at the end of the session. The discussion will then be referred to the authors for reply. Written discussion will be accepted up to two months following publication of any article in the JOURNAL.

A discussion section is published semiannually in the JOURNAL.

MEETING ROOM SCHEDULES

Meetings	Monday		Tuesday		Wednesday		Thursday	
	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.
Electric Insulation					C	C		
Electronics—								
Luminescence	B	B	B	B				
Rare Metals							E	E
Screen Application					E	E		
Semiconductors				C	B	B		
Electro-Organics			E	E	D			
Electrothermics	C	C	C					
Theoretical Electrochemistry—								
Symposium	A	A	A	A	A	A		
General		D					A	A

A—Meeting will be held in Sky Top.
B—Meeting will be held in Penn Top, South.
C—Meeting will be held in Penn Top, North.
D—Meeting will be held in Penn Top, Center.
E—Meeting will be held in the Keystone Room.

Technical Program

Monday, April 13, 1953

9:00 A.M.—Formal Opening of the 103rd Convention with Introduction by General Chairman Harry R. Copson, and response by President-Elect Robert J. McKay. (Sky Top).

ELECTRIC INSULATION

Wednesday, April 15, 1953

with R. A. Ruscetta presiding
(PENN TOP, NORTH)

9:00 A.M.—**"The Use of Asbestos in Electric Insulation"** by Oliver Bowles, U. S. Department of the Interior, Bureau of Mines, Constructions and Chemical Materials Branch, Washington, D. C. (Abstract No. 1)

9:45 A.M.—**"New Developments in the Manufacture of Synthetic Fiber Paper"** by Hanns F. Arledter, Hurlbut Paper Company, South Lee, Mass. (Abstract No. 2)

10:15 A.M.—**"Positive D-C Corona on Polyethylene-Insulated Wire in Air"** by D. S. Rodbell and J. B. Whitehead, The Johns Hopkins University, Department of Electrical Engineering, Baltimore, Md. (Abstract No. 3)

10:45 A.M.—**"The Surface and Volume Loss on Dielectrics Under Alternating Stress"** by J. J. Chapman, The Johns Hopkins University, Baltimore, Md. (Abstract No. 4)

11:15 A.M.—**"Polyelectrolytes"** by W. P. Hohenstein and H. Mark, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. (Abstract No. 5)

12:30 P.M.—Electric Insulation Luncheon in honor of Peter Debye. Dr. Debye's lecture is entitled "The Electrical Interpretation of Molecular Forces in Its Historical Development."

Electric Insulation (cont'd.)
with C. Frank Miller presiding
(PENN TOP, NORTH)

2:00 P.M.—**"The Color of the Tantalum Oxide Film Predicts Certain Characteristics of the Tantalum Electrolytic Capacitor"** by A. F. Tor-

risi, Capacitor Department, General Electric Company, Hudson Falls, N. Y.
(Abstract No. 6)

2:45 P.M.—"Quinones as Ion Source in Hydrocarbons" by Andrew Gemant, Engineering Laboratory and Research Department, The Detroit Edison Company, Detroit, Mich.
(Abstract No. 7)

3:15 P.M.—"Stability of 2,6-di-tert-butyl-paracresol Inhibited Transformer Oil in an Arc" by R. N. Hazelwood, K. Oura, and R. M. Frey, Line Material Company, South Milwaukee, Wis. (Abstract No. 8)

3:45 P.M.—"The Electrical Properties of Selected Liquids" by Thomas D. Callinan, Naval Research Laboratory, Washington, D. C.
(Abstract No. 9)

ELECTRONICS—LUMINESCENCE

Monday, April 13, 1953

with Horace H. Homer presiding
(PENN TOP, SOUTH)

9:15 A.M.—Introductory remarks by Arthur L. Smith.

9:20 A.M.—"Radioluminescence of Phosphors" by James H. Schulman, Metallurgy Division, Naval Research Laboratory, Washington, D. C.
(Invited Paper)

10:05 A.M.—"Preliminary Studies on Luminescence and Tenebrescence of Synthetic Hackmanite-Like Materials" by Russell D. Kirk, Metallurgy Division, Naval Research Laboratory, Washington, D. C. (Abstract No. 10)

10:25 A.M.—"Luminescence of the System β $Zn_3(PO_4)_2$–$Cd_3(PO_4)_2$:Mn" by Arthur L. Smith and A. D. Power, Tube Department, Radio Corporation of America, Lancaster, Pa.
(Abstract No. 11)

10:50 A.M.—"Luminescence of Calcium Fluoride Activated by Cerium and Manganese" by Robert J. Ginther, Metallurgy Division, Naval Research Laboratory, Washington, D. C.
(Abstract No. 12)

11:10 A.M.—"New Manganese-Activated Fluoride Phosphors" by Arthur L. Smith, Tube Department, Radio Corporation of America, Lancaster, Pa. (Abstract No. 13)

11:30 A.M.—"The Measurement of Quantum Efficiency of Fluorescent Lamp Phosphors" by Charles W. Jerome, Sylvania Electric Products Inc., Salem, Mass. (Abstract No. 14)

11:50 A.M.—"The Oxidation States of Europium in Alkaline-Earth Oxide and Sulfide Phosphors" by P. Jaffe and E. Banks, Department of Chemistry, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. (Abstract No. 15)

12:30 P.M.—Society Luncheon and Annual Business Meeting in the Keystone Room.

Electronics—Luminescence (cont'd.)

with Robert J. Ginther presiding

(PENN TOP, SOUTH)

2:00 P.M.—"One Dimensional Disorder in ZnS Single Crystals" by L. W. Strock and V. A. Brophy, Physics Laboratories, Sylvania Electric Products Inc., Bayside, N. Y. (Abstract No. 16)

2:30 P.M.—"Vibrational Fine Structure in Luminescence Emission" by Clifford C. Klick, Metallurgy Division, Naval Research Laboratory, Washington, D. C. (Abstract No. 17)

2:50 P.M.—"The Constitution of the Green and Blue Luminogene Centers of Zinc Sulfide Phosphors Activated with Copper" by Edmond Grillot, Laboratoire de Luminescence, Faculté des Sciences (P.C.B.), Paris, France. (Abstract No. 18)

3:20 P.M.—"Fluorescence and Phosphorescence of ZnS Phosphors" by Keith H. Butler, Sylvania Electric Products Inc., Salem, Mass. (Abstract No. 19)

3:40 P.M.—"Factors Affecting the Emission Spectra of Manganese-Activated Phosphors" by Arthur L. Smith, Tube Department, Radio Corporation of America, Lancaster, Pa. (Abstract No. 20)

4:10 P.M.—"Radiationless Electron Transitions in the Lattice of Crystalline Phosphors" by Michael Schön, OSRAM Research Laboratory, Mosbach Branch, Baden, Germany. (Abstract No. 21)

4:30 P.M.—Social Hour: The Luminescence Section will hold a social hour from 4:30 to 6:00 P.M. Admittance by ticket only. Penn Top, South.

Tuesday, April 14, 1953

Electronics—Luminescence (cont'd.)
with Arthur L. Smith presiding
(PENN TOP, SOUTH)

9:30 A.M.—"Copper-Activated Zinc Sulfide Phosphors with Yellow and Red Emission" by H. C. Froelich, Lamp Development Laboratory, General Electric Company, Nela Park, Cleveland, Ohio. (Abstract No. 22)

9:50 A.M.—"Copper-Activated Zinc Sulfide Phosphors with Trivalent Substituents" by H. C. Froelich, Lamp Development Laboratory, General Electric Company, Nela Park, Cleveland, Ohio. (Abstract No. 23)

10:10 A.M.—"The Copper Content of H_2S-Fired ZnS:Cu Phosphors" by H. C. Froelich and F. W. Pikus, Lamp Development Laboratory, General Electric Company, Nela Park, Cleveland, Ohio. (Abstract No. 24)

10:30 A.M.—"Electroluminescent Zinc Sulfide Phosphors" by Horace H. Homer, Richard M. Rulon, and Keith H. Butler, Sylvania Electric Products Inc., Salem, Mass. (Abstract No. 25)

11:00 A.M.—"Electroluminescence of Insulated Phosphor Particles" by Laurence Burns, Sylvania Electric Products Inc., Salem, Mass. (Abstract No. 26)

11:20 A.M.—"Luminescence of Electroluminescent ZnS Phosphors Under the Influence of Step-Functions of Unidirectional Field" by John F. Waymouth and Francis Bitter, Sylvania Electric Products Inc., Salem, Mass. (Abstract No. 27)

11:40 A.M.—"Electroluminescent Sulfide Phosphors, I. Chemical Nature" by P. Zalm, H. A. Klasens, and G. Diemer, Research Laboratories, N. V. Philips' Gloeilampenfabrieken, Eindhoven, Holland. (Abstract No. 28)

12:10 P.M.—"Electroluminescent Sulfide Phosphors, II. Electrical and Optical Measurements" by G. Diemer and P. Zalm Research Laboratories, N. V. Philips' Gloeilampenfabrieken, Eindhoven, Holland. (Abstract No. 29)

12:30 P.M.—Electronics Division Luncheon and Business Meeting in the Keystone Room.

Round Table
ELECTRONICS—LUMINESCENCE
with Luke Thorington presiding
(PENN TOP, SOUTH)

2:00-5:00 P.M.—Round-Table Discussion.

ELECTRONICS—RARE METALS

Thursday, April 16, 1953

with A. U. Seybolt presiding
(KEYSTONE ROOM)

9:30 A.M.—"Investigation of Some Factors Related to the Deposition of Boron" by Russell H. Atkinson and John C. R. Kelly, Jr., Research Department, Westinghouse Electric Corporation, Bloomfield, N. J. (Abstract No. 30)

10:00 A.M.—"Improving the Purity of Powder Metallurgy Molybdenum" by John C. R. Kelly, Jr., and Alan G. Caterson, Research Department, Westinghouse Electric Corporation, Bloomfield, N. J. (Abstract No. 31)

10:30 A.M.—"Diffusion of Cobalt in Molybdenum" by E. S. Byron and V. E. Lambert, Westinghouse Electric Corporation, Bloomfield, N. J. (Abstract No. 32)

11:00 A.M.—"Kilogram Scale Reductions of Vanadium Pentaoxide to Vanadium Metal" by Arthur P. Beard and Donald D. Crooks, Knolls Atomic Power Laboratory, General Electric Company, Schenectady, N. Y. (Abstract No. 33)

11:30 A.M.—"Mechanical Properties of High Purity Vanadium" by C. M. Brown, Electro-Metallurgical Company, Niagara Falls, N. Y. (Abstract No. 34)

Electronics—Rare Metals (cont'd.)
with Donald M. Wroughton presiding
(KEYSTONE ROOM)

2:00 P.M.—"Lithium as a Reducing Agent in the Production of Other Metals" by R. R. Rogers and G. E. Viens, Mines Branch, Department of Mines and Technical Surveys, Division of Mineral Dressing and Process Metallurgy, Ottawa, Ontario, Canada. (Abstract No. 35)

2:30 P.M.—"Preparation of a New Series of Alkali Titanium Halides of Lower Valent Titanium" by Joseph M. Sherfey and Abner Brenner, National Bureau of Standards, Washington, D. C. (Abstract No. 36)

3:00 P.M.—"The Preparation of Zirconium Metal by Arc Dissociation of Halides" by James H. Moore, National Research Corporation, Cambridge, Mass. (Abstract No. 37)

3:30 P.M.—"Studies on the Mechanism of Hydrogen Reaction with Zirconium" by Earl A. Gulbransen and Kenneth F. Andrew, Westinghouse Research Laboratories, East Pittsburgh, Pa. (Abstract No. 38)

ELECTRONICS—PHOSPHOR SCREEN APPLICATION

Wednesday, April 15, 1953

with W. J. Hindman presiding

(KEYSTONE ROOM)

9:00 A.M.—Introductory Remarks by A. E. Hardy.

9:05 A.M.—"Milling of Phosphors" by A. Steadman, Allen B. DuMont Laboratories, Inc., Clifton, N. J. (Abstract No. 39)

9:25 A.M.—"Particle Size Distribution of Phosphors" by Martha J. Bergin and Keith H. Butler, Sylvania Electric Products Inc., Salem, Mass. (Abstract No. 40)

9:40 A.M.—"Determination of Size Distribution of Solid Aggregates and Phosphors in Suspension" by W. Rublack, Radio Corporation of America, Victor Division, Marion, Ind. (Abstract No. 41)

10:00 A.M.—"Potassium Silicates for the Preparation of Cathode Ray Screens" by Wm. Stericker, Philadelphia Quartz Company, Philadelphia, Pa. (Abstract No. 42)

10:20 A.M.—"The Measurement of the Dry Adherence of Kinescope Screens" by H. Duecker and C. T. Lattimer, Radio Corporation of America, Victor Division, Marion, Ind. (Abstract No. 43)

10:45 A.M.—"Streaming Potential Studies of Phosphors, Glasses, and Gels" by George L.

Schnable and J. Fred Hazel, University of Pennsylvania, Philadelphia, Pa.
(Abstract No. 44)

11:05 A.M.—"On the Collection of Secondary Electrons in a Kinescope" by G. P. Kirkpatrick, Tube Department, Radio Corporation of America, Lancaster, Pa. (Abstract No. 45)

11:15 A.M.—"Polarographic Determination of Cadmium and Zinc in Zinc Sulfide-Cadmium Sulfide Phosphors" by Samuel B. Deal, Tube Department, Radio Corporation of America, Lancaster, Pa. (Abstract No. 46)

11:25 A.M.—"A Study of Metallic Impurities Through Oxide Cathode Coatings" by Armand P. LaRocque and Gerald K. Clymer, Tube Development Laboratory, Philco Corporation, Lansdale, Pa. (Abstract No. 47)

11:40 A.M. — "The Preparation of Phosphor Screens for Color Television Tubes" by Sidney Levy and Albert K. Levine, Sylvania Electric Products Inc., Bayside, N. Y.
(Abstract No. 48)

Round Table

Phosphor Screen Application
with R. B. Snyder presiding
(KEYSTONE ROOM)

2:15 P.M.—Round-Table Discussion.

ELECTRONICS—SEMICONDUCTORS

Tuesday, April 14, 1953

with H. R. Harner presiding
(PENN TOP, NORTH)

2:00 P.M.—Opening address by H. R. Harner.

2:20 P.M.—"Resistivity Striations in Germanium Metal" by Paul R. Camp, Radio Corporation of America, RCA Laboratories Division, Princeton, N. J. (Abstract No. 49)

2:50 P.M.—"Phenomena Observed in the Melting and Solidification of Germanium" by S. E. Bradshaw, Research Laboratories, General Electric Company, Ltd., Wembly, England.
(Abstract No. 50)

ELECTRONICS—SEMICONDUCTORS (cont'd.)

3:20 P.M.—"Germanium Metal Preparation and Its Effect on Diode Characteristics" by A. S. Rugare, General Electric Company, Clyde, N. Y. (Abstract No. 51)

3:50 P.M.—"Application of Zone-Melting Techniques to the Purification of Rare Metals" by W. G. Pfann, Bell Telephone Laboratories, Inc., Murray Hill, N. J. (Abstract No. 52)

4:20 P.M.—"Vapor Phase Deposition of Germanium by Reduction of the Chlorides" by W. E. Medcalf, R. K. Riel, and C. E. Smith, Eagle-Picher Research Laboratories, Joplin, Mo. (Abstract No. 53)

Wednesday, April 15, 1953

Electronics—Semiconductors (cont'd.)
with J. B. Merrill presiding
(PENN TOP, SOUTH)

9:30 A.M.—"Electrical Properties of Semiconducting Al-Sb" by R. K. Willardson, A. C. Beer, and A. E. Middleton, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 54)

10:00 A.M.—"Preparation and Properties of Lead Telluride Single Crystals" by Edward L. Brady, Research Laboratory, General Electric Company, Schenectady, N. Y. (Abstract No. 55)

10:30 A.M.—"Influence of Composition and Temperature on the Resistivity of Some Alkaline Earth Titanates" by E. K. Weise, University of Illinois, Urbana, Ill., and I. A. Lesk, General Electric Company, Electronics Laboratory, Syracuse, N. Y. (Abstract No. 56)

11:00 A.M.—"The Nitrides of Chromium and Chromium-Titanium Alloys—New Film-Type Resistance Elements" by E. R. Olson, E. H. Layer, and A. E. Middleton, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 57)

11:30 A.M.—General Discussion.

Wednesday, April 15, 1953

Electronics—Semiconductors (cont'd.)
with Martin F. Quaely presiding
(PENN TOP, SOUTH)

2:00 P.M.—"Radiochemical Activity Analysis and Germanium Purification" by George H.

Morrison, Physics Laboratories, Sylvania Electric Products Inc., Bayside, N. Y.
(Abstract No. 58)

2:25 P.M.—"Applications of Radioisotopes in the Study of Semiconductors" by J. D. Struthers, Bell Telephone Laboratories, Inc., Murray Hill, N. J. (Abstract No. 59)

2:50 P.M.—"Interaction of Hole and Electron Currents in Point Contact Transitor Structures" by Maynard H. Dawson, Sylvania Electric Products Inc., Newton Highlands, Mass.
(Abstract No. 60)

3:15 P.M.—"Frequency Variations of Junction-Transistor Parameters" by R. L. Pritchard, Research Laboratory, General Electric Company, Schenectady, N. Y. (Abstract No. 61)

ELECTRO-ORGANIC CHEMISTRY

Tuesday, April 14, 1953

with Christopher Wilson presiding

(KEYSTONE ROOM)

9:00 A.M.—"The Electrolytic Reduction of Diisopropyl Ketone" by Sherlock Swann, Jr., D. K. Eads, and L. H. Krone, Jr., Department of Chemistry, University of Illinois, Urbana, Ill.
(Abstract No. 62)

9:20 A.M.—"Reduction of Furfural: Structure of the Resin" by Donald Staker and Christopher Wilson, Ohio State University, Columbus, Ohio. (Abstract No. 63)

9:40 A.M.—"The Electrolytic Reduction of a Branched Chain Aliphatic Aldehyde in Acid Solution" by Sherlock Swann, Jr., E. I. Onstott, and F. H. Baastad, Department of Chemistry, University of Illinois, Urbana, Ill.
(Abstract No. 64)

10:00 A.M.—"Attempts at the Electrolytic Initiation of Polymerization" by H. Z. Friedlander, Sherlock Swann, Jr., and C. S. Marvel, Department of Chemistry, University of Illinois, Urbana, Ill. (Abstract No. 65)

10:20 A.M.—"The Electrolysis of Salts of Fatty Acids in the Same Anhydrous Acids" by Stefan Goldschmidt, Institut der Technicischen Hochschule, München, Germany. (Abstract No. 66)

10:40 A.M.—"Studies on the Improvement of the Electrolytic Process of the Preparation of Organic Compound: Electrolytic Reduction of Nitrobenzene to Hydrazobenzene" by Kiichiro Sugino and Taro Sekine, Laboratory of Organic Electrochemistry, Tokyo Institute of Technology, Chiba, Japan. (Abstract No. 67)

11:00 A.M.—"Studies on the Mechanism of the Electrolytic Formation of Perchlorate" by Kiichiro Sugino and Shigeru Aoyagi, Laboratory of Organic Electrochemistry, Tokyo Institute of Technology, Chiba, Japan. (Abstract No. 68)

Tuesday, April 14, 1953

Electro-Organic Chemistry (cont'd.)
with Stanley Wawzonek presiding
(KEYSTONE ROOM)

2:15 P.M.—"Effect of Chain Branching on Electrochemical Carbon-Halogen Fission—Possible Mechanism for the Process" by Philip J. Elving and Joseph M. Markowitz, University of Michigan, Ann Arbor, Mich., and Isadore Rosenthal, Pennsylvania State College, State College, Pa. (Abstract No. 69)

2:35 P.M.—"Polarography of Thioglycolic Acid" by D. L. Leussing and I. M. Kolthoff, School of Chemistry, University of Minnesota, Minneapolis, Minn. (Abstract No. 70)

2:55 P.M.—"A Millicoulometer Method for the Determination of Polarographic *n*-Values" by Thos. De Vries and James Kroon, Department of Chemistry, Purdue University, Lafayette, Ind. (Abstract No. 71)

3:15 P.M. — "The Behavior of Organic Compounds at the Dropping Mercury Electrode in Anhydrous Methansulfonic Acid" by S. Wawzonek and D. F. Thomson, Department of Chemistry and Chemical Engineering, State University of Iowa, Iowa City, Iowa. (Abstract No. 72)

3:35 P.M.—"Polarography in Nonaqueous Solvents—The Use of Glycerol at Elevated Temperatures" by Thos. De Vries and D. B. Bruss, Department of Chemistry, Purdue University, Lafayette, Ind. (Abstract No. 73)

3:55 P.M.—"The Polarographic Behavior of Zinc in Strongly Alkaline Solutions" by Thedford P. Dirkse, Department of Chemistry, Calvin College, Grand Rapids, Mich. (Abstract No. 74)

4:15 P. M. — "Polarographic Determination of the System, *o*-Nitroanisole, *o*-Chloronitrobenzene, and *o*-Nitrophenol" by Shinichi Kikuchi and Kenichi Honda, Laboratory of Electrochemistry and Photochemistry, Institute of Industrial Science, University of Tokyo, Chiba, Japan. (Abstract No. 75)

4:35 P.M.—"Effect of Structure on the Polarographic Reduction of Iodo-Compounds" by Eugene L. Colichman, Livermore Research Laboratory, California Research and Development Company, Livermore, Calif. (Abstract No. 76)

Wednesday, April 15, 1953

Electro-Organic Chemistry (cont'd.)

Round Table

Anodic Reactions

with Sherlock Swann presiding

(PENN TOP, CENTER)

9:00 A.M.-12:00 M.—Round-Table Discussion. Speakers: W. Urry, C. Wilson, M. Janes, R. P. Linstead, B. C. L. Weedon, G. W. Thiessen, and W. MacNevin.

12:30 P.M.—Electro-Organic Chemistry Division Luncheon in Parlor 1.

ELECTROTHERMICS

Monday, April 13, 1953

Laboratory and Commercial Equipment, Processes, and Products

with J. S. Dewar presiding

(PENN TOP, NORTH)

9:30 A.M.—"Inert Atmosphere Forging" by Carl Kolbe, Metallurgy Research Department, General Electric Company, Schenectady, N. Y. (Abstract No. 77)

10:00 A.M.—"Possibilities of Making Steel from Ore in a Duplex Electric Furnace Operation" by H. S. Newhall, Pittsburgh Lectromelt Furnace Corporation, Pittsburgh, Pa. (Abstract No. 78)

10:30 A.M.—"Flexible Leads for Low Frequency Electric Arc Furnaces" by M. Eaton, Shawini-

gan Chemicals Limited, Shawinigan Falls, Canada, and S. B. Thomas, Northern Electric Company Limited, Montreal, Canada.
(Abstract No. 79)

11:00 A.M.—"Energy Losses from Furnaces and the Concept of Efficiency" by Victor Paschkis, Department of Mechanical Engineering, Columbia University, New York, N. Y.
(Abstract No. 80)

11:30 A.M.—"Induction Heating—Design of Inductors" by Anthony Vescuso, Lepel High Frequency Laboratories, Inc., New York, N. Y.
(Abstract No. 81)

Electrothermics (cont'd.)

Laboratory and Commercial Equipment, Processes, and Products

with I. E. Campbell presiding

(PENN TOP, NORTH)

2:00 P.M.—"Status of Research on Electromagnetic Levitation of Solid and Molten Metals" by D. M. Wroughton, G. Comenetz, and P. H. Brace, Westinghouse Electric Corporation, Pittsburgh, Pa., and John C. R. Kelly, Jr., and E. C. Okress, Westinghouse Electric Corporation, Bloomfield, N. J. (Abstract No. 82)

2:30 P.M.—"Arc Melting as a Laboratory Tool" by H. R. Ogden and R. I. Jaffee, Battelle Memorial Institute, Columbus, Ohio.
(Abstract No. 83)

3:00 P.M.—"Vacuum Arc Melting—Controlling the Purity of Molybdenum" by G. W. P. Rengstorff, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 84)

3:30 P.M.—"An Apparatus for Determination of the Solidus Temperatures of High-Melting Alloys" by R. A. Oriani and T. S. Jones, General Electric Research Laboratory, Schenectady, N. Y. (Abstract No. 85)

4:00 P.M.—"The Use of Radiant Energy in High Temperature, High Speed, or Controlled Atmospheric Heating" by C. F. Powell, Battelle Memorial Institute, Columbus, Ohio.
(Abstract No. 86)

4:30 P.M.—"Construction of Molybdenum Wound Furnaces" by D. F. Taylor, Fansteel Metallurgical Corporation, North Chicago, Ill.
(Abstract No. 87)

Tuesday, April 14, 1953

Electrothermics (cont'd.)

Laboratory and Commercial Equipment, Processes, and Products

with C. H. Chappell presiding

(PENN TOP, NORTH)

9:30 A.M.—"Hot-Pressing Furnaces" by J. A. Upper, Norton Company, Niagara Falls, Canada. (Abstract No. 88)

10:00 A.M.—"Electrical Conduction by Columns of SiC Grit" by G. H. Fetterley, Norton Company, Niagara Falls, Canada. (Abstract No. 89)

10:30 A.M.—"The Effect of Color and Crystal Size of Silicon Carbide on the Exponent Characteristics of Varistor Disks" by C. J. Frosch, Bell Telephone Laboratories, Inc., Murray Hill, N. J. (Abstract No. 90)

11:00 A.M.—"The Electrical Resistivity of Heat-Treated Carbon Blacks" by W. D. Schaeffer, W. R. Smith, and M. H. Polley, Godfrey L. Cabot, Inc., Cambridge, Mass. (Abstract No. 91)

12:30 P.M.—Electrothermic Division Luncheon in Parlor B.

THEORETICAL ELECTROCHEMISTRY

Monday, April 13, 1953

Symposium on Application of Electrochemistry to Biology and Medicine

General Chairman—Detlev W. Bronk, Ph.D.
Program Chairman—Walter J. Hamer, Ph.D.

with Detlev W. Bronk presiding

(SKY TOP)

9:15 A.M.—Introductory Remarks by Detlev W. Bronk, Johns Hopkins University, Baltimore, Md.

9:30 A.M.—"Molecular Structure and Diffusion in Aqueous Solution" by L. G. Longsworth, Ph.D., The Rockefeller Institute for Medical Research, New York, N. Y. (Abstract No. 92)

THEORETICAL ELECTROCHEMISTRY
(cont'd.)

10:10 A.M.—"Activity Coefficients of Some Sodium and Potassium Phosphates in Reference to Biological Cation Concentration Gradients" by Fred M. Snell, M.D., Ph.D., Department of Biology, Massachusetts Institute of Technology, Cambridge, Mass. (Abstract No. 93)

10:50 A.M.—"The Galvanic Cell" by T. Shedlovsky, Ph.D., The Rockefeller Institute for Medical Research, New York, N. Y. (Abstract No. 94)

11:35 A.M.—"Electrochemical Phenomena in Plant Cells" by L. R. Blinks, Ph.D., Hopkins Marine Station, Stanford University, Pacific Grove, Calif. (Abstract No. 95)

Symposium on Application of Electrochemistry to Biology and Medicine (cont'd.)

with Theodore Shedlovsky, Ph.D., presiding

(SKY TOP)

2:00 P.M.—"Electrical Signs of Epileptic Discharge" by Herbert H. Jasper, M.D., Montreal Neurological Institute, McGill University, Montreal, Canada. (Abstract No. 96)

2:45 P.M.—"Electroencephalographic Localization of Brain Tumors" by B. K. Bagchi, Ph.D., The Neuropsychiatric Institute, University Hospital, University of Michigan, Ann Arbor, Mich. (Abstract No. 97)

3:30 P.M.—"Review of Electrophoresis into the Human Skin" by Harold A. Abramson, M.D., New York, N. Y. (Abstract No. 98)

4:15 P.M.—"Some Problems Arising in the Clinical Interpretation of Electrocardiograms" by Franklin D. Johnston, M.D., Heart Station, Department of Internal Medicine, University of Michigan Medical School, Ann Arbor, Mich. (Abstract No. 99)

Monday Dinner

7:00 P.M.—Society Dinner with speaker to be announced. Subject to pertain to the Symposium on Application of Electrochemistry to Biology and Medicine.

Tuesday, April 14, 1953

Symposium on Application of Electrochemistry to Biology and Medicine (cont'd.)

with L. R. Blinks, Ph.D., presiding

(SKY TOP)

9:00 A.M.—"Membrane Potentials in the Donnan Equilibrium, II" by David I. Hitchcock, Ph.D., and Alexander Mauro, Ph.D., Laboratory of Physiology, Yale University School of Medicine, New Haven, Conn. (Abstract No. 100)

9:45 A.M.—"Membranes, Their Electrochemistry, and Their Use in Model Studies of Biological Interest" by Karl Sollner, Ph.D., Sheldon Dray, M.D., Eugene Grim, Ph.D., and Rex Neihof, Ph.D., National Institute of Arthrit s & Metabolic Diseases, National Institutes o Health, Public Health Service, Federal Security Agency, Bethesda, Md. (Abstract No. 101)

10:30 A.M.—"On the Nature of the Membrane Potential of Frog Nerve" by R. Lorente de Nó, M.D., The Rockefeller Institute for Medical Research, New York, N. Y. (Abstract No. 102)

11:15 A.M.—"Dynamic Negative Resistance in Statically Stable Membranes" by Otto H. Schmitt, Ph.D., Departments of Physics and Zoology, University of Minnesota, Minneapolis, Minn. (Abstract No. 103)

Symposium on Application of Electrochemistry to Biology and Medicine (cont'd.)

with Herbert H. Jasper, M.D., presiding

1:45 P.M.—"The Implementation of Electrical Energy by Paired Half-Centers as Revealed by Structure and Function" by Robert Gesell, M.D., Physiology Laboratory, University of Michigan, Ann Arbor, Mich. (Abstract No. 104)

2:30 P.M.—"The Effects of Changes in the Internal Composition of the Single Nerve Fiber on the Bioelectric Potential" by Harry Grundfest, Ph.D., Department of Neurology, College of Physicians and Surgeons, Columbia University, New York, N. Y. (Abstract No. 105)

3:15 P.M.—"Ions, Potentials, and the Nerve Impulse" by Kenneth S. Cole, Ph.D., Naval Medi-

cal Research Institute, National Naval Medical Center, Bethesda, Md. (Abstract No. 106)

4:00 P.M.—"The Molecular Basis of Nerve Action Potentials" by David Nachmansohn, M.D., Department of Neurology, Columbia University, College of Physicians and Surgeons, New York, N. Y. (Abstract No. 107)

Wednesday, April 15, 1953

Symposium on Application of Electrochemistry to Biology and Medicine (cont'd.)
with Duncan A. MacInnes, Ph.D., presiding
(SKY TOP)

9:00 A.M.—"Light Scattering Studies on Kinetic and Equilibrium Relations in the Formation of Mercaptalbumin Mercury Dimer" by John T. Edsall, M.D., Ephraim Katchalski, Ph.D., and Robert H. Maybury, Ph.D., University Laboratory of Physical Chemistry, Related to Medicine and Public Health, Harvard University, Boston, Mass. (Abstract No. 108)

9:40 A.M.—"Ion Exchanger Electrodes" by George Scatchard, Ph.D., Department of Chemistry, Massachusetts Institute of Technology, Cambridge, Mass. (Abstract No. 109)

10:20 A.M.—"The Determination of the Activity of Small Ions in Protein Solutions with Collodion Membrane Electrodes" by Charles W. Carr, Ph.D., Department of Physiological Chemistry, University of Minnesota, Minneapolis, Minn. (Abstract No. 110)

10:55 A.M.—"Hydrogen Ion Titration Curves of Proteins" by Charles Tanford, Ph.D., Department of Chemistry, State University of Iowa, Iowa City, Iowa. (Abstract No. 111)

11:30 A.M.—"Some Aspects of Bioelectrical Phenomena" by W. J. V. Osterhout, Ph.D., The Rockefeller Institute for Medical Research, New York, N. Y. (Abstract No. 112)

Symposium on Application of Electrochemistry to Biology and Medicine (cont'd.)
with Duncan A. MacInnes, Ph.D., presiding
(SKY TOP)

1:45 P.M.—"Chemical Specificity in Biological Interactions" by Edwin J. Cohn, Ph.D., Doug-

las M. Surgenor, Ph.D., Frank R. N. Gurd, Ph.D., Margaret J. Hunter, Ph.D., and Walter L. Hughes, Jr., Ph.D., University Laboratory of Physical Chemistry, Related to Medicine and Public Health, Harvard University, Boston, Mass. (Abstract No. 113)

2:25 P.M.—"Polarographic Study of Proteins and Their Degradation Products, IV. The Behavior of Various Fractions of Plasma Proteins" by Otto H. Müller, Ph.D., School of Medicine, Department of Physiology, State University of New York, Medical Center, Syracuse, N. Y. (Abstract No. 114)

3:00 P.M.—"Dielectric Studies in Concentrated Protein Solutions" by J. L. Oncley, Ph.D., and H. M. Dintzis, Ph.D., University Laboratory of Physical Chemistry, Harvard University, Boston, Mass. (Abstract No. 115)

3:40 P.M.—"A Demonstration of the Lillie Iron Wire Nerve Conduction Model" by R. L. Taylor, M.S., D. R. Turner, Ph.D., and H. M. Straube, B.S.E.E., Bell Telephone Laboratories, Inc., Murray Hill, N. J.
(Abstract No. 116)

THEORETICAL ELECTROCHEMISTRY

Monday, April 13, 1953

General Theoretical Session

with Walter J. Hamer presiding

(PENN TOP, CENTER)

2:00 P.M.—"Kinetics of Layer Formation on Copper Anodes in HCl and KCl Solutions" by J. H. Bartlett and Lee Stephenson, Department of Physics, University of Illinois, Urbana, Ill. (Abstract No. 117)

2:25 P.M.—"An Optical Method (Schlieren) for the Quantitative Investigation of Diffusion Layers" by Lee Stephenson, Department of Physics, University of Illinois, Urbana, Ill.
(Abstract No. 118)

2:50 P.M.—"Electrochemical Polarization of Zirconium in Sodium Chloride Solution" by Norman Hackerman and Olin B. Cecil, Department of Chemistry, University of Texas, Austin, Texas. (Abstract No. 119)

3:15 P.M.—"Structural Features of Oxide Coatings on Aluminum" by F. Keller, M. S. Hunter, and D. L. Robinson, Aluminum Research Laboratories, Aluminum Company of America, New Kensington, Pa. (Abstract No. 120)

3:40 P.M.—"Experimental Study of 'Potential-*p*H-Rate of Corrosion' Diagrams" by Paul Delahay, George L. Stiehl, John A. Perry, and Talivaldis Berzins, Department of Chemistry, Louisiana State University, Baton Rouge, La. (Abstract No. 121)

4:10 P.M.—"Electrolysis at Constant Current" by Paul Delahay and Talivaldis Berzins, Department of Chemistry, Louisiana State University, Baton Rogue, La. (Abstract No. 122)

Thursday, April 16, 1953

Theoretical Electrochemistry
General Theoretical Session (cont'd.)

with Walter J. Hamer presiding

(SKY TOP)

9:00 A.M.—"The Acid Dissociation of the Aquoscandium Ions, II. Effect of Temperature and of Ionic Strength" by Martin Kilpatrick and Lewis Pokras, Department of Chemistry, Illinois Institute of Technology, Chicago, Ill. (Abstract No. 123)

9:25 A.M.—"Cation Exchange Process for the Preparation of Potassium Cyanide" by C. H. Lemke, Research Division, Electrochemicals Department, E. I. du Pont de Nemours & Company, Inc., Niagara Falls, N. Y. (Abstract No. 124)

9:50 A.M.—"The Preparation and Electrochemical Properties of Iron and Cobalt Phosphides" by Donald W. Wood, Standard Oil Development Company, Esso Research Center, Development Division, Linden, N. J., and John C. Bailar, Jr., Herbert A. Laitinen, and Sherlock Swann, Jr., Department of Chemistry, University of Illinois, Urbana, Ill. (Abstract No. 125)

10:15 A.M.—"Equivalent-Circuit Model of the Transference Cell" by George W. Murphy, Argonne National Laboratory, Lemont, Ill. (Abstract No. 126)

10:40 A.M.—"Current Distribution Over Electrodes of Finite Conducivity" by Charles W. Tobias, Department of Chemistry and Chemical Engineering, and Robert A. Wijsman, Department of Physics, University of California, Berkeley, Calif. (Abstract No. 127)

11:05 A.M.—"Polarization Measurements with the Oxygen Electrode" by R. R. Witherspoon, Ernest Yeager, Herman Urbach, and Frank Hovorka, Department of Chemistry, Western Reserve University, Cleveland, Ohio. (Abstract No. 128)

11:30 A.M.—"Ionic Vibration Potentials" by Ernest Yeager, Harry Dietrick, Frank Saunders, and Frank Hovorka, Department of Chemistry, Western Reserve University, Cleveland, Ohio. (Abstract No. 129)

11:55 A.M.—Theoretical Electrochemistry Division Business Meeting in the Sky Top.

Theoretical Chemistry (cont'd.)
General Theoretical Session
with Walter J. Hamer presiding

(SKY TOP)

2:00 P.M.—"On the Electrochemistry of Ion-Exchange Resins" by K. S. Spiegler, Department of Chemistry and Laboratory for Nuclear Science and Engineering, Massachusetts Institutue of Technology, Cambridge, Mass. (Abstract No. 130)

2:25 P.M.—"Apparatus for Studying Electrogravitational Separations: Some Experiments on the Extraction of Sodium Chloride from Solution in a Flow System" by George W. Murphy and David Batzer, Department of Chemistry, University of Wisconsin, Madison, Wis. (Abstract No. 131)

2:50 P.M.—"Stabilization of the Divalent State of Silver Through Coordination" by A. L. McClelland, Department of Chemistry, University of Connecticut, Storrs, Conn., and J. C. Bailar, Jr., and H. A. Laitinen, Department of Chemistry, University of Illinois, Urbana, Ill. (Abstract No. 132)

3:15 P.M.—"Rate of Displacement of Silver from Aqueous Solutions of Silver Nitrate by Zinc and Copper" by Richard Glicksman, Henri Mouquin, and Cecil V. King, Department of

Chemistry, Washington Square College, New York University, New York, N. Y.
(Abstract No. 133)

3:40 P.M.—"Effect of Stress on Metal Electrode Potentials" by Robert E. Fryxell and Norman H. Nachtrieb, Institute for the Study of Metals, University of Chicago, Chicago, Ill.
(Abstract No. 134)

4:05 P.M.—"Electrochemical Properties of Dilute Sodium Amalgams" by Harry Dietrick, Ernest Yeager, and Frank Hovorka, Department of Chemistry, Western Reserve University, Cleveland, Ohio. (Abstract No. 135)

ABSTRACTS

ELECTRIC INSULATION

ABSTRACT NUMBER 1

THE USE OF ASBESTOS IN ELECTRIC INSULATION

Oliver Bowles

THE applications of asbestos in building materials, in heat insulation, and in making friction materials and fireproof fabrics are familiar uses, but its role in electric insulation is less widely known. Asbestos is not chosen for electric uses because of its superior dielectric properties but because its fibrous form and fire-resistance adapt it peculiarly to certain important insulating uses such as coverings for electric cables. Most of the asbestos of commerce is, in fact, a poor insulator because of its iron content. The limited supply of low-iron fiber throughout the world has created a critical situation, and various efforts have been, and are being, made to offset this deficiency. The steps taken to augment supplies of low-iron fiber, to develop substitutes, to purify high-iron asbestos, and to manufacture synthetic fiber are discussed in some detail. The discovery of a new deposit in British Columbia, Canada, that may supplement current supplies of low-iron asbestos is discussed.

ABSTRACT NUMBER 2

NEW DEVELOPMENTS IN THE MANUFACTURE OF SYNTHETIC FIBER PAPER

Hanns F. Arledter

IN Part I, the historical background, the chemistry of inorganic fibers used for papermaking, the chemical stability, and the physical (including the electrical) properties of these inorganic synthetic fibers will be covered. In Part II the physical properties of inorganic fiber paper in comparison with asbestos and mica paper shall be discussed. New paper grades developed in our research laboratory will be compared with NRL paper grades. A discussion of new developments in regard to teflon, silicone, rubber, melamine, phenolic, etc., bonded glass fiber papers will fol-

low. The paper will close with an outlook in the future giving a progress report on trials to manufacture paper with lower and high density, of papers with very low thicknesses, etc.

ABSTRACT NUMBER 3

POSITIVE D-C CORONA ON POLYETHYLENE-INSULATED WIRE IN AIR

D. S. Rodbell and J. B. Whitehead

THIS paper outlines an investigation of an apparent anomaly in the electric strength of air about polyethylene-insulated wires. Results show that the air does break down when the gradient exceeds the accepted value for the electric strength of air, but the discharge is not maintained. An explanation of this self-quenching action is given.

ABSTRACT NUMBER 4

THE SURFACE AND VOLUME LOSS ON DIELECTRICS UNDER ALTERNATING STRESS

J. J. Chapman

THE separation of surface and volume loss by experiment, rather than by mathematical deductions from combined effects was accomplished for the direct current case in 1947. This present report deals with a similar separation under conditions of alternating stress.

ABSTRACT NUMBER 5

POLYELECTROLYTES

W. P. Hohenstein and H. Mark

THE group of polymeric substances, called polyelectrolytes because of their electrical characteristics in solution, has been the subject of intensive fundamental and applied research during the last few years. Recent investigations have helped to clarify some of the fundamental relationships between the shape of the polyelectro-

lyte molecules in solution and the extent to which such molecules are ionized.

On the other hand the solution properties of polyelectrolytes give some important clues to the behavior of these substances in certain biological phenomena. Likewise their application in various industries, for instance in agriculture, in the textile and in food industries, are based on their characteristical solution behavior.

ABSTRACT NUMBER 6

THE COLOR OF THE TANTALUM OXIDE FILM PREDICTS CERTAIN CHARACTERISTICS OF THE TANTALUM ELECTROLYTIC CAPACITOR

A. F. Torrisi

THE interference colors of anodic tantalum oxide are shown to be a function of the thickness of the oxide. Measurements of thickness by several methods involve a study of the parameters of density, refractive index, chemical composition of the film, and mechanism of film formation. The thickness of the tantalum oxide film can be measured gravimetrically by comparison with the barium stearate, stepgauge, observations of dark and bright (maxima and minima) with a sodium light, and the recording spectrophotometer. All these methods are in agreement except the gravimetric procedure. The gravimetric method would also be in agreement if the anodic film has a density of 6.5. A lower density of anodic tantalum oxide lends strength to the theory that the oxide film has some sort of gaseous layer. Further indications along this line are borne out by the large change in capacity of an anodized foil after heating at several hundred degrees with little or no change in weight of the tantalum foil. The suggestion is that some oxygen traveled from the film to the metal.

ABSTRACT NUMBER 7

QUINONES AS ION SOURCE IN HYDROCARBONS

Andrew Gemant

WHEN ortho-dyhydric phenol solutions in hydrocarbons or dioxane are subjected to oxi-

dation, marked increase in electric conductivity takes place. Various aspects of this observation were studied experimentally, such as: the effect of the time of oxidation; effect of dilution; decay with time of the conductivity; d-c polarization; role of quinone concentration; effect of temperature of oxidation. The experimental results are tentatively explained by a generation during oxidation of intermediate ionic stages of relatively high stability. These oxidative ions, both positive and negative, might be semiquinones having completed electric shells. Ions of this type appear to be representative of ions formed during oxidation of dielectric liquids.

ABSTRACT NUMBER 8

STABILITY OF 2,6-DI-TERT-BUTYL-PARA-CRESOL INHIBITED TRANSFORMER OIL IN AN ARC

R. N. Hazelwood, K. Oura, and R. M. Frey

DISCUSSED in this paper are the selection of suitable oxidation inhibitors for transformer oil and the differences in decomposition of inhibited and uninhibited oils in an arc. In addition, some comments are offered on the testing of oils in general.

ABSTRACT NUMBER 9

THE ELECTRICAL PROPERTIES OF SELECTED LIQUIDS

Thomas D. Callinan

THE dielectric constant and dielectric loss factor of selected dielectric liquids are evaluated in terms of free energy and entropy. The viscosity, surface tension, molar volumes, and conductivity of each liquid are presented. Emphasis is placed on the necessity of comparing the electrical qualities only when the liquids are in corresponding states.

ABSTRACT NUMBER **10**

PRELIMINARY STUDIES ON LUMINESCENCE AND TENEBRESCENCE OF SYNTHETIC HACKMANITE-LIKE MATERIALS

Russell D. Kirk

THE tenebrescent and luminescent properties typical of the rare mineral hackmanite have been closely duplicated by synthesis of a series of sodalite-type materials of the general formula $3(Na_2O \cdot Al_2O_3 \cdot 2SiO_2) \cdot x\ NaCl \cdot y\ Na_2S \cdot z\ Na_2SO_4$. Synthesis was by firing together the component salts and oxides at 900°C in a controlled atmosphere. Exposure of hackmanite and the synthetic products to a low-pressure mercury-arc source produces a violet coloration. Luminescence emissions of the natural and synthetic are identical in spectral distribution.

ABSTRACT NUMBER **11**

LUMINESCENCE OF THE SYSTEM $\beta Zn_3(PO_4)_2$–$Cd_3(PO_4)_2$:Mn

Arthur L. Smith and A. D. Power

WHEN β zinc-orthophosphate and cadmium-orthophosphate mixtures are activated by manganese and fired at 850°C, phosphors are obtained whose luminescence is not a linear function of the mole proportions of the initial ingredients. The peak-emission vs. composition curve shows several abrupt breaks, which correspond to abrupt phase changes as determined by x-ray diffraction analysis.

ABSTRACT NUMBER **12**

LUMINESCENCE OF CALCIUM FLUORIDE ACTIVATED BY CERIUM AND MANGANESE

Robert J. Ginther

CERIUM - ACTIVATED calcium fluoride and manganese-activated calcium fluoride phos-

phors have been previously reported. The present paper describes a sensitized phosphor activated by both cerium and manganese. Cerium introduces absorption bands in calcium fluoride at 2500 Å, 3050 Å, and 3300 Å with ultraviolet emission at 3200 Å and at wavelengths longer than 3400 Å. High cerium concentrations favor the creation of the 2500 Å absorption band. The manganese emission is efficiently sensitized upon absorption in only the two short wavelength bands.

ABSTRACT NUMBER **13**

NEW MANGANESE-ACTIVATED FLUORIDE PHOSPHORS

Arthur L. Smith

THE following manganese-activated fluorides were found to exhibit efficient cathodoluminescence: $NaZnF_3$, $KZnF_3$, K_2ZnF_4, $NaMgF_3$, $KMgF_3$, K_2MgF_4, CaF_2, $KCaF_3$, $KCdF_3$, and the solid solutions formed between CaF_2 and AlF_3. With MgF_2 and ZnF_2, AlF_3 was found to be only a diluent; with CaF_2, however, the emission shifted progressively from a peak of 4950 Å for CaF_2 to 5220 Å for the composition $0.25CaF_2$–$0.75AlF_3$. Emission of Mg and Zn compounds containing K or Na was almost identical to that of the original MgF_2 and ZnF_2. Although CaF_2:Mn has an efficient green and CdF_2 a weak green emission, their K perovskites show strong yellow-orange emission. From the above results, a hypothesis is advanced relating a coordination number of six for the divalent cation in fluorides to orange emission, and a coordination number of eight to green emission.

ABSTRACT NUMBER **14**

THE MEASUREMENT OF QUANTUM EFFICIENCY OF FLUORESCENT LAMP PHOSPHORS

Charles W. Jerome

A METHOD is described for calculating the quantum efficiency of a phosphor incorporated in a fluorescent lamp. This involves calculating the theoretical maximum luminous efficiency (LPW) of the lamp and comparing

thereto the LPW determined by photometry. Some data are presented comparing results obtained by this method with those obtained using magnesium tungstate as a reference standard.

ABSTRACT NUMBER 15

THE OXIDATION STATES OF EUROPIUM IN ALKALINE-EARTH OXIDE AND SULFIDE PHOSPHORS

P. Jaffe and E. Banks

THE conclusions of Brauer[1] concerning the oxidation state of europium in alkaline-earth oxides and sulfides have been verified by a study of absorption and emission spectra. The reduction of europium to the divalent state in CaO and SrO has been accomplished by hydrogen reduction. The result of the reduction is the replacement of the line emission of Eu^{+3} by the band emission of Eu^{+2}. A new absorption band, analogous to those in the sulfides, is also introduced. Hydrogen treatment of MgO:Eu does not give rise to Eu^{+2} emission, probably because of the great disparity in ionic size.

[1] *Z. Naturforsch.*, **6a**, 561 (1951).

ABSTRACT NUMBER 16

ONE DIMENSIONAL DISORDER IN ZnS SINGLE CRYSTALS

L. W. Strock and V. A. Brophy

SYNTHETIC ZnS crystals grown from the vapor phase exhibit polytypic structures consisting of 2-, 3-, 4-, and 6-layered hexagonal unit cells. All four types are frequently present in small transparent single crystals. In others, 2- and 3-layer structures are present, but these occur alone only infrequently in crystals grown to date. These structural features are being correlated with the luminescent properties of the crystals and with their growth habits and growing techniques.

ABSTRACT NUMBER 17

VIBRATIONAL FINE STRUCTURE IN LUMINESCENCE EMISSION

Clifford C. Klick

RECENT approaches to the problem of using configuration coordinate curves in a quantitative way are reviewed. The vibrational energy levels which should appear in this approximation are shown to account for the temperature dependence of the emission band width, fine structure observed in some emission spectra, and possibly the asymmetrical emission in divalent manganese-activated materials. Limitations of the configuration coordinate curve approximation are discussed.

ABSTRACT NUMBER 18

THE CONSTITUTION OF THE GREEN AND BLUE LUMINOGENE CENTERS OF ZINC SULFIDE PHOSPHORS ACTIVATED WITH COPPER

Edmond Grillot

ON THE basis of experimental results, the following simple models are proposed: a "blue center" would be constructed with a copper ion only surrounded by sulfur ions, and a "green center" with a copper ion the neighbors of which include an oxygen ion. With the aid of these two simple models, the influences of various factors, especially of the action of gaseous oxygen, of copper content, of the composition of the firing atmosphere, and of the added ZnO concentration, upon the numerical distribution of these two kinds of centers may be predicted qualitatively and, for some of them, in order of magnitude.

ABSTRACT NUMBER 19

FLUORESCENCE AND PHOSPHORESCENCE OF ZnS PHOSPHORS

Keith H. Butler

A NEW theory of fluorescence of zinc sulfide phosphors is proposed, which relates the ob-

served emission colors of the phosphors to the spectrographic energy levels of zinc, copper, silver, gold, and manganese present as atoms rather than ions. The different behavior of silver and copper is qualitatively accounted for, both for fluorescence and phosphorescence, and the necessity for halide or group III atoms is explained. A further extension of the theory to explain trapping and infrared stimulation is possible.

ABSTRACT NUMBER 20

FACTORS AFFECTING THE EMISSION SPECTRA OF MANGANESE-ACTIVATED PHOSPHORS

Arthur L. Smith

ANALYSIS of the emission spectra of divalent manganese-activated phosphors shows that three factors influence the position of the emission band: (*a*) the nature of the anion, (*b*) the number of anions coordinated about the cation, and (*c*) the radius of the cation for which manganese substitutes. The influence of the first two factors is reviewed, and proof of the influence of the third factor is given. It is shown that when the anion and the coordination number are fixed the emission is then a function of the radius of the cation. The variation in radius might account for the width of the spectral band. An extension of the theory to other activators is also offered.

ABSTRACT NUMBER 21

RADIATIONLESS ELECTRON TRANSITIONS IN THE LATTICE OF CRYSTALLINE PHOSPHORS

Michael Schön

IF CRYSTALLINE phosphors with recombination radiation are considered in terms of the band model and if transitions from traps to the valence band, usually without radiation, are permitted, then the conditions affecting the yield, in particular the intensity of the excitation, are properly given. The energy position and the concentration of the traps are critical. With a rather small concentration of deep traps (distance from the conduction band greater than that of the

activator level to the valence band) the superlinearity observed by Nail, Urbach, and Pearlmon was obtained. The general conditions for luminescence have been obtained. Also the behavior under intense excitation is satisfactorily described. Under certain conditions the coefficients for radiationless recombination may be determined from the experimental yield curves. From this a simple criterion is obtained for determining if a lattice defect will function as an activator or a trap.

ABSTRACT NUMBER **22**

COPPER-ACTIVATED ZINC SULFIDE PHOSPHORS WITH YELLOW AND RED EMISSION

H. C. Froelich

HEXAGONAL, H_2S - fired, and NaCN - washed ZnS:Cu phosphors prepared with 0.05 to 1 per cent Cu show prominent emission in a red band at 6700 Å and a weaker yellow band at 5800 Å when excited with ultraviolet, cathode rays, x-rays, or electroluminescence, and when stimulated by infrared. The bands have different temperature dependencies and different ultraviolet excitation sensitivities. With electroluminescent excitation, the yellow-red emission persists over the frequency range of 60 to 15,000 cps.

ABSTRACT NUMBER **23**

COPPER-ACTIVATED ZINC SULFIDE PHOSPHORS WITH TRIVALENT SUBSTITUENTS

H. C. Froelich

INCREASING concentrations of Cu and Al shift the emission of H_2S-fired Zn(Al)S:Cu phosphors from green to orange. The emission consists of three sub-bands with different temperature, decay, and excitation characteristics. Some rare earths produce *IR* stimulable phosphors. When fired in atmospheres of H_2S plus oxides, the phosphors with Al become strongly electroluminescent. Their emission is green at all frequencies from 60 to 15,000 cps.

ABSTRACT NUMBER **24**

THE COPPER CONTENT OF H_2S-FIRED ZnS:Cu PHOSPHORS

H. C. Froelich and F. W. Pikus

USING two colorimetric methods of analysis, the Cu content of NaCN-washed ZnS:Cu phosphors was found to increase with increasing initial concentration of Cu and with firing time and temperature, approaching a limit of solubility near 0.3 per cent Cu. Most phosphors retained between about 0.05 and 0.15 per cent Cu.

ABSTRACT NUMBER **25**

ELECTROLUMINESCENT ZINC SULFIDE PHOSPHORS

Horace H. Homer, Richard M. Rulon, and Keith H. Butler

THE preparation of blue, green, and yellow electroluminescent zinc sulfide phosphors is described. The blue and green phosphors contain copper and lead, with the color being determined by the copper and chloride concentration. The yellow phosphors are triple-activated, containing copper, lead, and manganese.

ABSTRACT NUMBER **26**

ELECTROLUMINESCENCE OF INSULATED PHOSPHOR PARTICLES

Laurence Burns

SOME results are presented from a purely theoretical consideration of the luminescence of a surface layer on a semiconductor phosphor particle embedded in a dielectric medium and subjected to an electric field.

ABSTRACT NUMBER **27**

LUMINESCENCE OF ELECTROLUMINESCENT ZnS PHOSPHORS UNDER THE INFLUENCE OF STEP-FUNCTIONS OF UNIDIRECTIONAL FIELD

John F. Waymouth and Francis Bitter

EXPERIMENTAL data is presented on the integrated light output (ILO) from electroluminescent ZnS phosphors when they are subjected to "step-function" of unidirectional field. The "rise time" of the field step-function could be adjusted between 50 and 500,000 microseconds. Over this range, the variation of ILO with rise and decay times was small. It was found for all phosphors that ILO displayed a dependence on the charging history of the sample which could be correlated with the development of a frozen polarization within the sample.

ABSTRACT NUMBER **28**

ELECTROLUMINESCENT SULFIDE PHOSPHORS

I. Chemical Nature

P. Zalm, H. A. Klasens, and G. Diemer

AN account is given of the preparation of electroluminescent zinc sulfide powders. The preparation is based on the assumption that a surface barrier on the phosphor is required. Evidence is given to support this assumption. The light is emitted by the side of the crystal that is turned to the cathode.

ABSTRACT NUMBER **29**

ELECTROLUMINESCENT SULFIDE PHOSPHORS

II. Electrical and Optical Measurements

G. Diemer and P. Zalm

ELECTRO-OPTICAL measurements on electroluminescent powders are described, including various oscillograms of suspended and "dry" layers, and stroboscopic observation of the individual crystals by means of a microscope. The maximum efficiency is 1.5 ($\pm$0.2) lumen/watt, the brightness with 600 volt 3000 Hz is about 1000 lumen/m^2. The hypothesis of a barrier action at the surface from which the light originates is confirmed. The smallness of the efficiency is explained in view of the fact that the light is produced by a kind of cathode ray excitation at low voltage and high current density.

ELECTRONICS—RARE METALS

ABSTRACT NUMBER 30

INVESTIGATION OF SOME FACTORS RELATED TO THE DEPOSITION OF BORON

Russell H. Atkinson and John C. R. Kelly, Jr.

DURING the reaction, $2BCl_3 + 3H_2 \xrightarrow{\triangle} 2B + 6HCl$, it has been observed that the rate of deposition of boron on a hot tantalum wire remains almost constant over a 400°C range when reaction is initiated at 1800°C. This, coupled with the observation that the positions of the isotherms around the heat source remain unchanged regardless of coated area, has led to the conclusion that reaction takes place in the vapor phase at some distance from the surface of the tantalum with subsequent condensation of the boron on the nearest cool surface.

ABSTRACT NUMBER 31

IMPROVING THE PURITY OF POWDER METALLURGY MOLYBDENUM

John C. R. Kelly, Jr., and Alan G. Caterson

ASSUMING that the as-recrystallized brittleness of molybdenum is due to extremely small quantities of oxygen, nitrogen, and carbon, experiments were designed to reduce or eliminate contamination by those elements. The resulting metal is considerably softer than any previously reported samples. Preliminary tests indicate an improvement in room temperature plasticity.

ABSTRACT NUMBER 32

DIFFUSION OF COBALT IN MOLYBDENUM

E. S. Byron and V. E. Lambert

THE diffusion coefficients for cobalt in molybdenum were determined at 900°, 1100°, 1275°, 1500°, and 1700°C. In the equation relating diffusion coefficient with temperature, $D = Ae^{-Q/RT}$,

the activation energy Q derived was 34,800 cal/mole, and the constant A was determined as 2.82 x 10^{-6} cm^2/sec.

ABSTRACT NUMBER 33

KILOGRAM SCALE REDUCTIONS OF VANADIUM PENTAOXIDE TO VANADIUM METAL

Arthur P. Beard and Donald D. Crooks

THE process of producing ductile vanadium metal, as described by McKechnie and Seybolt,[1] has been scaled up to produce buttons of 750-1000 grams. A description of equipment, procedures, and vanadium produced in this work will be given in detail.

[1]R. K. McKechnie and A. U. Seybolt, *J. Electrochem. Soc.*, **97**, 311 (1950).

ABSTRACT NUMBER 34

MECHANICAL PROPERTIES OF HIGH PURITY VANADIUM

C. M. Brown

MECHANICAL properties have been determined on several vanadium metal heats containing various amounts of carbon, oxygen, and nitrogen. These elements influence mechanical properties, with impact strength being most seriously affected. Data are given on the transition from ductile to brittle fracture. Observations on the microstructure also are included.

ABSTRACT NUMBER 35

LITHIUM AS A REDUCING AGENT IN THE PRODUCTION OF OTHER METALS

R. R. Rogers and G. E. Viens

HITHERTO, due to its high cost, lithium has not been considered seriously as a reducing agent for the production of other metals. However, it has advantages which should make it attractive in a number of cases. The cost of the lithium may be reduced substantially by using a

recycling process, and still further cost reduction doubtless will result when lithium is produced on a larger scale. The results of preliminary reduction experiments, in which a number of different metals were produced, will be presented.

ABSTRACT NUMBER 36

PREPARATION OF A NEW SERIES OF ALKALI TITANIUM HALIDES OF LOWER VALENT TITANIUM

Joseph M. Sherfey and Abner Brenner

A GREAT deal of current interest exists in the development of a process for the electrowinning of titanium. However, very little has been published on the subject. In this and other laboratories titanium has been deposited from a melt containing either K_2TiF_6 or $TiCl_3$. A melt containing the latter compound has some advantages since it may be operated at lower current densities than one using K_2TiF_6, but the compound is difficult to prepare and handle.

This paper describes the preparation and some of the properties of a new series of anhydrous alkali titanium halides in which the valence of titanium is approximately three. These compounds may be of value for the electrodeposition of titanium from fused salt baths. The constitution of these substances has not been fully established but they appear to be mixtures of the type $MTiX_4$ and M_2TiX_5, where M is an alkali metal and X is chlorine, bromine, or iodine. They are prepared by the direct combination of the alkali metal with the tetrahalide of titanium. The value of these compounds for electrodepositing titanium is now being determined.

ABSTRACT NUMBER 37

THE PREPARATION OF ZIRCONIUM METAL BY ARC DISSOCIATION OF HALIDES

James H. Moore

EQUIPMENT was developed to produce zirconium tetraiodide and to dissociate it in an arc to form an ingot of zirconium metal. Factors affecting the yield in the dissociation reaction were investigated. Conversions of from 16.4 to

97.7 per cent were obtained, depending primarily upon the feed rate, and a maximum yield of 255 g/hr was obtained. At this yield, about 30 kwhr/lb were required to dissociate and maintain a molten pool.

ABSTRACT NUMBER **38**

STUDIES ON THE MECHANISM OF HYDROGEN REACTION WITH ZIRCONIUM

Earl A. Gulbransen and Kenneth F. Andrew

THE rate of reaction has been found to be sensitive to surface films, surface preparation, heat treating cycles, and to nonmetallic impurities. Experiments are made on the effect of oxide films and the hydrogen, nitrogen, and oxygen compositions on the rate of reaction. Oxide film appears to be the major factor affecting the rate of hydriding. Oxygen and nitrogen in solid solution have only minor effects on the rate of reaction.

ELECTRONICS—PHOSPHOR SCREEN APPLICATION

ABSTRACT NUMBER **39**

MILLING OF PHOSPHORS

A. Steadman

THE subject is discussed on the basis of the experience of approximately 20 years in working with luminescent materials. A usable method for milling silicate, tungstate, phosphate, or oxide phosphors is presented together with some comparisons of the luminous efficiency of salts so treated vs. other methods of grinding. Some test results on the milling of sulfides are presented which have been accepted as indicating the difference in the physical structure of sulfide phosphors from that of the silicate, tungstate, phosphate, or oxide types.

ABSTRACT NUMBER **40**

PARTICLE SIZE DISTRIBUTION OF PHOSPHORS

Martha J. Bergin and Keith H. Butler

A QUICK method of calculating particle size distribution from optical measurements of sedimentation rates is described. It is shown that the apparent mean diameter is greatly influenced by the degree of dispersion of the powder and that reproducibility requires careful control of dispersion.

ABSTRACT NUMBER **41**

DETERMINATION OF SIZE DISTRIBUTION OF SOLID AGGREGATES AND PHOSPHORS IN SUSPENSION

W. Rublack

A MODIFIED apparatus developed for a distribution analysis of uniformly mixed suspensions of phosphors by the pressure method is described. Methods of measuring the rate of sedimentation are discussed. This method is applicable to many materials other than phosphors. The cumulative and distribution curves are defined and the treatment of the results is discussed. A simple geometric construction is indicated whereby the root mean square radius of the sample is obtained very simply.

ABSTRACT NUMBER **42**

POTASSIUM SILICATES FOR THE PREPARATION OF CATHODE RAY SCREENS

Wm. Stericker

THE solutions of potassium silicates used to adhere cathode ray screens fall in the range of $K_2O:3.2SiO_2$ to $K_2O:4.0SiO_2$. Methods of analysis for the principal constituents are discussed. Typical chemical and spectrographic determinations of impurities are given. These potassium silicates are colloidal electrolytes. The

silica present as complex negative ions and micelles can be condensed or further complexed by the addition of organic liquids, other salts, or acidic materials.

ABSTRACT NUMBER 43

THE MEASUREMENT OF THE DRY ADHERENCE OF KINESCOPE SCREENS

H. Duecker and C. T. Lattimer

THE development of a process for the measurement of the adherence of dried luminescent screens to the faceplates on which they are deposited is presented. The major emphasis of this program was to develop a procedure which could be used to test the screens of production kinescopes. The procedure for testing these screens is included, together with graphs showing the effects of the variables in the procedure on the results obtained. Also included are graphs showing comparisons between the wet and dry adherence of typical barium nitrate-potassium silicate settled screens.

ABSTRACT NUMBER 44

STREAMING POTENTIAL STUDIES OF PHOSPHORS, GLASSES, AND GELS

George L. Schnable and J. Fred Hazel

THE relationship of the adhesion of phosphors on cathode ray screens to the zeta potentials of phosphors and of glasses has been investigated by the streaming potential method. Considerable decrease in the rate of flow of certain mixtures through streaming cells is attributed to the formation of silica gel on the surface of the solid under test. When the flow rate is less than about 10 per cent of normal the zeta potential calculated corresponds approximately to that of the silica gel formed. This phenomenon occurs at approximately the same concentration as good screen formation.

ABSTRACT NUMBER **45**

ON THE COLLECTION OF SECONDARY ELECTRONS IN A KINESCOPE

G. P. Kirkpatrick

THE secondary electron current from the screen to various parts of the second anode in a kinescope has been measured. It was found that (*a*) the section nearest to the screen is the most effective collector; (*b*) if this section is not an operating collector, it becomes charged and may radically change the distribution and efficiency of collection; and (*c*) such a change will produce screen charging and lower light output and may be a mechanism involved in x-burn.

ABSTRACT NUMBER **46**

POLAROGRAPHIC DETERMINATION OF CADMIUM AND ZINC IN ZINC SULFIDE-CADMIUM SULFIDE PHOSPHORS

Samuel B. Deal

THIS paper describes a method for the quantitative determination of cadmium and zinc using lead as internal standard.

The method consists of measuring the diffusion currents of cadmium and zinc ions relative to the diffusion current of lead ion. By a comparison of the results obtained with a calibration curve, the concentrations of cadmium and zinc are determined.

Use is made of a methyl red-bromcresol green maximum suppressor, potassium chloride base solution, and a modified electrolysis cell.

The method is simple and rapid in application and the necessity for constant temperature control is eliminated.

ABSTRACT NUMBER **47**

A STUDY OF METALLIC IMPURITIES THROUGH OXIDE CATHODE COATINGS

Armand P. LaRocque and Gerald K. Clymer

IN ORDER to determine the effect of metallic impurities on the emission from oxide cathode

coatings, nine individuate metals were added to a standard coprecipitated alkaline-earth triple carbonate coating. These metals, chosen for their reducing power and the thermal stability of their oxides, were aluminum, columbium, magnesium, silicon, tantalum, thorium, titanium, tungsten, and zirconium. The standard diode, as proposed by the ASTM, was the experimental tube and the procedures for processing and testing were those also advocated by the ASTM. It was found that the addition of several of the metals, particularly columbium, had a beneficial effect, at least with regard to emission during the first few hours of life.

ABSTRACT NUMBER **48**

THE PREPARATION OF PHOSPHOR SCREENS FOR COLOR TELEVISION TUBES

Sidney Levy and Albert K. Levine

A METHOD is described for producing accurately registered fine detail patterns of color phosphors suitable for use in a color television cathode ray tube. The method is photographic in nature. The desired phosphor pattern is produced by irradiating a thin film of photosensitive material containing dispersed phosphor with a suitable light pattern.

ELECTRONICS—SEMICONDUCTORS

ABSTRACT NUMBER **49**

RESISTIVITY STRIATIONS IN GERMANIUM METAL

Paul R. Camp

GERMANIUM metal, both single crystalline and polycrystalline, is frequently found to contain sharp fluctuations in impurity concentration. These are superimposed on the gradual variations of impurity concentration expected as the result of ordinary segregation processes.

A rather simple technique for detecting fluctuations of this kind, which is more sensitive than resistivity scanning and which does not involve the use of radioactive tracers, will be de-

scribed. This technique has been applied to a number of samples. The origin, value, and elimination of these fluctuations will be discussed briefly.

ABSTRACT NUMBER 50

PHENOMENA OBSERVED IN THE MELTING AND SOLIDIFICATION OF GERMANIUM

S. E. Bradshaw

THE shape of a germanium ingot was shown to involve the ratio of the densities of solid and liquid germanium, D_s/d_l, at the melting point. From the value obtained for d_s/d_l it was deduced that the melting point of germanium is lowered by an increase of pressure. Spheres of molten germanium, ~ 10 mgm, form pear-shaped solids on freezing and it was shown that impurity segregation occurs in a manner similar to that obtained in ingots.

ABSTRACT NUMBER 51

GERMANIUM METAL PREPARATION AND ITS EFFECT ON DIODE CHARACTERISTICS

A. S. Rugare

THE successful operation of a germanium product manufacturing line depends on an intimate knowledge of the metal which will be used. Considerable work has been done correlating the effect of various types of germanium metal with the subsequent whisker diode characteristics achieved.

Whether the problem is one of securing a high back voltage or back resistance diode or one of securing a diode possessing high rectification efficiency, a specific type of metal preparation is resorted to. This has led to the refinement of purification techniques used on germanium metal, the investigation of polycrystalline and single crystal germanium, and the development of metal quality control.

ABSTRACT NUMBER **52**

APPLICATION OF ZONE-MELTING TECHNIQUES TO THE PURIFICATION OF RARE METALS

W. G. Pfann

A SIMPLE, one-step method of purification by repeated fractional crystallizations from the melt has been developed. Known as zone-melting, the method consists of slowly passing a series of molten zones through a long solid impure ingot. It greatly reduces the time required for a series of crystallizations and eliminates the need for separating the pure and impure fractions after each crystallization. Factors involved in applying zone-refining to various solute-solvent systems will be discussed and data will be given for germanium.

ABSTRACT NUMBER **53**

VAPOR PHASE DEPOSITION OF GERMANIUM BY REDUCTION OF THE CHLORIDES

W. E. Medcalf, R. K. Riel, and C. E. Smith

GERMANIUM was deposited on metallic and nonmetallic bases by hydrogen reduction of the tetrachloride. Coatings 10 to 75 microns thick having desirable electrical properties were deposited on graphite, lavite, and quartz. The coatings were composed of small crystallites with very little coherence. The size of the crystallites and their electrical properties were markedly affected by the support temperature. Subsequent heat treatment significantly increased the coherence and markedly affected the current-voltage characteristics of the coatings.

ABSTRACT NUMBER **54**

ELECTRICAL PROPERTIES OF SEMICONDUCTING Al-Sb

R. K. Willardson, A. C. Beer, and A. E. Middleton

PRELIMINARY measurements of some of the electrical properties of the compound Al-Sb

indicate semiconducting characteristics comparable with those reported for silicon. Data were taken on the electrical resistivity, thermoelectric power, and Hall voltage as a function of temperature over the range from 90° to 800°K. Rectification characteristics were measured for both *p*- and *n*-type samples of various resistivities. Both photovoltaic and photodiode effects have been observed.

ABSTRACT NUMBER 55

PREPARATION AND PROPERTIES OF LEAD TELLURIDE SINGLE CRYSTALS

Edward L. Brady

SINGLE crystals of lead telluride have been prepared by reaction of spectrographic grade components in a silica or carbon tube, followed by lowering of the melt through a temperature gradient. In each crystallization, the bulk of the material is *p*-type, with *n*-type impurities concentrating in the last portions to crystallize. Stoichiometry of the lead telluride is difficult to control. Resistivity and Hall coefficient measurements were obtained on both *n*- and *p*-type crystals.

ABSTRACT NUMBER 56

INFLUENCE OF COMPOSITION AND TEMPERATURE ON THE RESISTIVITY OF SOME ALKALINE EARTH TITANATES

E. K. Weise and I. A. Lesk

THE titanates of magnesium, calcium, strontium, and barium were prepared by reactions in the solid state, and purities of the six compounds checked by means of x-ray powder diffraction analysis.

A family of resistivity-temperature curves was obtained for each titanate with stoichiometric composition, and in various stages of reduction. The temperature range from 30° to 1400°C was used, and resistivity values between 10^{-1} and 10^{8} ohm/cm were measured.

ABSTRACT NUMBER **57**

THE NITRIDES OF CHROMIUM AND CHROMIUM-TITANIUM ALLOYS — NEW FILM-TYPE RESISTANCE ELEMENTS

E. R. Olson, E. H. Layer, and A. E. Middleton

SEVERAL alloy systems of the IV-, V-, and VI-group refractory metals have been evaluated for applications as film-type resistance elements. Most extensive study has been concentrated on the Cr-N and Cr-Ti-N systems. Resistance elements covering a wide resistance range and exhibiting low temperature coefficients of resistance have been made by varying the thickness and composition of films of these materials. Preparation, reproducibility, and chemical stability of these films will be discussed.

ABSTRACT NUMBER **58**

RADIOCHEMICAL ACTIVITY ANALYSIS AND GERMANIUM PURIFICATION

George H. Morrison

THE electrical behavior of semiconductor materials is greatly dependent upon the presence or absence of extremely small amounts of impurities. In the case of germanium, used in the transistor, it is important to analyze quantitatively for one part of impurity in 100 million parts of germanium. One of the few analytical methods operative in this concentration range is radiochemical analysis, which includes both activation analysis and tracer techniques.

Both chemical and physical methods of purification of germanium will be briefly described, followed by a discussion of the use of radioactive methods for the analysis of ultra trace amounts of impurities, as well as the development of methods of purification. These applications will be illustrated with specific examples in research.

ABSTRACT NUMBER **59**

APPLICATIONS OF RADIOISOTOPES IN THE STUDY OF SEMICONDUCTORS

J. D. Struthers

THE distribution coefficients and diffusion constants of certain impurities in semiconducting materials, particularly germanium, have been determined using radioactive isotopes. The techniques used in measuring these constants and the data obtained will be presented. Information relative to the uniformity of distribution of impurities has been obtained by means of radioautographs.

ABSTRACT NUMBER **60**

INTERACTION OF HOLE AND ELECTRON CURRENTS IN POINT CONTACT TRANSISTOR STRUCTURES

Maynard H. Dawson

ONE of the problems of transistor electronics is the large interaction of the emitter with the collector at large distances, in excess of 20 thousandths of an inch. This might be explained by the interaction between electron and hole currents, but quantitative evaluation of this effect is difficult for the geometry of the usual point contact transistor. A particular model is assumed for which calculations may be made. It is shown that one may account for the interactions if the intrinsic alpha of the collector is high enough.

ABSTRACT NUMBER **61**

FREQUENCY VARIATIONS OF JUNCTION-TRANSISTOR PARAMETERS*

R. L. Pritchard

A THEORETICAL solution for the frequency variation of the small-signal parameters of a junction transistor has been obtained by extending Shockley's analysis and by taking ac-

*This research was supported by the Government Tri-Services Contract AF 33(600) 17793, Semi-Conductors.

count of space-charge-layer widening as suggested by J. M. Early. The effect of spreading resistance in the base region is included only as a lumped resistance. From the results of this solution it has been possible to explain the experimentally observed frequency variation of the collector-base admittance of fused-contact *p-n-p* junction transistors.

ELECTRO-ORGANIC CHEMISTRY

ABSTRACT NUMBER **62**

THE ELECTROLYTIC REDUCTION OF DIISOPROPYL KETONE

Sherlock Swann, Jr., D. K. Eads, and L. H. Krone, Jr.

THE electrolytic reduction of diisopropyl ketone to the corresponding hydrocarbon, secondary alcohol, and pinacol in acid solution has been studied at cathodes of cadmium, zinc, lead, and mercury. Current density and temperature had little effect on yields over the range studied. It has been found that the character of the product is affected by the physical structure of the cathode material.

ABSTRACT NUMBER **63**

REDUCTION OF FURFURAL: STRUCTURE OF THE RESIN

Donald Staker and Christopher Wilson

THE reduction of furfural leads to furfuryl alcohol, two stereoisomeric pinacols and a resin (Alexander and Lowy). The present work deals with the structure of the latter material to see if its formation could be related to the existence of radicals.

Most experimental work was concerned with a dimer which can be isolated along with the pinacols. The dimer was shown to contain two furan rings, two hydroxyl groups but not alpha to one another, and a linking in the 5-position. The simplest explanation for the formation of the resin involves 1,6-reduction.

ABSTRACT NUMBER **64**

THE ELECTROLYTIC REDUCTION OF A BRANCHED CHAIN ALIPHATIC ALDEHYDE IN ACID SOLUTION

Sherlock Swann, Jr., E. I. Onstott, and F. H. Baastad

THE electrolytic reduction of isobutyraldehyde has been carried out at cathodes of cadmium, zinc, lead, and mercury. The influence of the physical condition of the surface of the cathode has been studied.

The preparation of the electrode was shown to have a marked effect on the character of the products obtained at cathodes of lead and zinc.

ABSTRACT NUMBER **65**

ATTEMPTS AT THE ELECTROLYTIC INITIATION OF POLYMERIZATION

H. Z. Friedlander,* Sherlock Swann, Jr., and C. S. Marvel

FOUR cathodic and four anodic reactions which should produce free radicals were carried out in the presence of a vinyl monomer under a wide variety of conditions. The cathodic reactions studied were the reduction of acetophenone and the discharge of methyl, benzylquinolinium, and *p*-bromobenzenediazonium ions. The reactions of the following anions were investigated: laurate, *p*-benzyl phenolate, hydroxyl, and tricarboethoxylmethyl. The various classes of emulsifiers were used, namely cationic, anionic, neutral ionic, and nonionic. The intermediates formed at the electrodes did not react with the monomers. A reinvestigation of the electrolytic reduction of acetophenone in acid solution is also reported.

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ABSTRACT NUMBER **66**

THE ELECTROLYSIS OF SALTS OF FATTY ACIDS IN THE SAME ANHYDROUS ACIDS

Stefan Goldschmidt

THE electrolysis of salts of fatty acids solved in anhydrous fatty acids of low molecular

weight was investigated. Acidyl radicals (I) arise primarily after the discharge. These radicals are decomposed partially, liberating CO_2, while alkyl radicals (II) originate:

$$\underset{}{R{-}COO^-} \rightarrow \underset{(I)}{R{-}COO^\cdot} \rightarrow \underset{(II)}{R^\cdot} + CO_2.$$

These react with the solvent forming secondary radicals, according to the "R-H" scheme. The secondary radicals are transformed into products, which have not been found during electrolysis until now, i.e., (IV).

$$R'{-}CH_2{-}COOH + R^\cdot \rightarrow \underset{(III)}{R'{-}\dot{C}H{-}COOH} + R{-}H$$

$$(III) \longrightarrow (R{-}CH{-}COOH)_2.$$
$$(IV)$$

Thus, the electrolysis of potassium propionate in anhydrous propionic acid furnished butylene, secondary butyl propionate, diethylketone, methylethyl-acetic acid, ethyl-propyl-acetic acid, and α, α'-dimethyl-succinic acid not mentioning the products formerly described.

In these experiments, the inorganic cation (K^+) could not participate in the formation of secondary products. Eventually, this would be possible using an organic cation, i.e., a tertiary amine, which could be dehydrated by the radicals primarily formed at the anode. Hence, pyridine was electrolyzed in a large excess of anhydrous propionic acid. In addition to the products mentioned above, we were able to isolate 2-ethylpyridine and 4-ethylpyridine, created by reaction of the ethyl radical with pyridine. We tried also to establish the existence of the radicals primarily formed during the electrolysis of the salts of fatty acids as mentioned above in another way. Hence, we added compounds suitable to polymerization, i.e., styrene or acrylonitrile, expecting these would be polymerized by the radicals formed at the anode binding the unstable radicals as end groups. Really the electrolysis of sodium acetate in acetic acid in presence of styrene furnished 2-phenylbutane, the acetates of 2-phenyl-1-propanol, and 2-3-diphenylpentanol, the diacetate of phenylglycol, γ, δ-diphenyl-hexane (mesoform and racemate), a polymeric fraction of low molecular weight (polymerization number 3-6) and a hemicolloidal fraction (average polymerization number 30). The analogous electrolysis of potassium propionate in anhydrous propionic acid with styrene added gave 3-phenylhexane, 2-phenyl-1-butylpropionate, phenylglycoldipropionate, δ, ϵ-diphenyloctane (mesoform and racemate), also a low molecular and a hemicolloidal fraction. When acrylonitrile was added, the electrolysis of potassium acetate in anhydrous glacial acetic acid

furnished α, α′-diethylsuccinic acid dinitrile. All these compounds are polymerization products of low molecular weight carrying as end groups unstable radicals primarily formed during the electrolysis.

ABSTRACT NUMBER 67

STUDIES ON THE IMPROVEMENT OF THE ELECTROLYTIC PROCESS OF THE PREPARATION OF ORGANIC COMPOUND: ELECTROLYTIC REDUCTION OF NITROBENZENE TO HYDRAZOBENZENE

Kiichiro Sugino and Taro Sekine

ELECTROLYTIC preparation of hydrazobenzene (benzidine) has been usually performed by the reduction of nitrobenzene suspended in a dilute alkali solution using a nickel or iron cathode. But in that process, the reduction of azobenzene (intermediate product) to hydrazobenzene was thought to be very difficult and various attempts were proposed to increase both the material and the current yield. The authors have studied on the improvement of this process and have found a more suitable method in which a suspension of nitrobenzene in 5 per cent aqueous alkali solution is reduced electrolytically using a zinc cathode. In our process, when the azobenzene formation was almost completed, alkali concentration of catholyte was increased to about 10 per cent to make the reaction proceed smoothly.

ABSTRACT NUMBER 68

STUDIES ON THE MECHANISM OF THE ELECTROLYTIC FORMATION OF PERCHLORATE

Kiichiro Sugino and Shigeru Aoyagi

(NO ABSTRACT RECEIVED)

ABSTRACT NUMBER **69**

EFFECT OF CHAIN BRANCHING ON ELECTROCHEMICAL CARBON-HALOGEN BOND FISSION — POSSIBLE MECHANISM FOR THE PROCESS

Philip J. Elving, Joseph M. Markowitz, and Isadore Rosenthal*

A GROUP of branched chain α-bromoalkanoic acids with several of their ethyl esters and straight chain isomers were investigated polarographically at 0°C over the *p*H range of 1 to 9. The relation between half-wave potential, $E_{1/2}$, and *p*H for the acids follows an S-shaped pattern having *p*H-invariant regions in the alkaline and acidic *p*H ranges, $E_{1/2}$ in the latter region being considerably more negative. The $E_{1/2}$ values for the esters are *p*H-independent, being slightly more positive than those of the corresponding acids in the acidic region. The polarographic waves all involve a two-electron reduction process, and are all diffusion-controlled. In the acidic *p*H region, the branched chain acids are more easily reducible than their straight chain isomers by 0.20 to 0.13 volt, the larger differences being observed for the lower molecular weight acids. In the alkaline region the situation is similar, but there are some apparent anomalies.

The possible course of the electrode reaction is considered in the light of the influence of *p*H, of chain length, and of chain branching. Certain aspects of a possible analysis of the *p*H-dependence are discussed and shortcomings of previous theoretical treatments are noted. Tentative hypotheses for a plausible reaction mechanism are advanced in terms of contemporary organic reactivity theory and steric concepts. Evidence is examined for an elimination process of either S_N1 or S_N2 pattern for the carbon-halogen bond fission, and some consideration is given to the possibility of a free radical mechanism. The anomolous behavior in the alkaline region is explained as the result of formation of certain ring structures which achieve stability only in the acids which behave anomolously.

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ABSTRACT NUMBER **70**

POLAROGRAPHY OF THIOGLYCOLIC ACID

D. L. Leussing and I. M. Kolthoff

THIOGLYCOLIC acid exhibits polarographic behavior at the dropping mercury electrode similar to cysteine and glutathione. A reversible anodic wave is found, the characteristics of which correspond to the formation of a mercurous thioglycolate complex. This wave is suitable for the analysis of thioglycolic acid in solutions. A second irreversible anodic wave probably is due to the formation of an insoluble mercuric monothioglycolate. The standard potential of the electrode reaction has been calculated from the experimental results. Dithiodiglycolic acid is irreversibly reduced to thioglycolic acid at the dropping mercury electrode. Calculated diffusion coefficients of various species from polarographic data are given.

ABSTRACT NUMBER **71**

A MILLICOULOMETER METHOD FOR THE DETERMINATION OF POLAROGRAPHIC *n*-VALUES

Thos. De Vries and James Kroon

IT IS possible to determine the value of *n* in the Ilkovic equation by using two polarographic cells in series and extending the electrolysis until reasonable decreases in wave heights have occurred. The cells contained approximately 0.15 ml, and 0.002*M* $CdCl_2$ in 0.1*M* KCl was used in the reference cell. The electrolysis time was about 100 minutes. The number of faradays per mole of electrode reaction was 1.00 for the thallous ion, 1.98 for fumaric acid, and 3.96 for *p*-nitrobenzoic acid, all with a precision of 2 per cent.

ABSTRACT NUMBER **72**

THE BEHAVIOR OF ORGANIC COMPOUNDS AT THE DROPPING MERCURY ELECTRODE IN ANHYDROUS METHANESULFONIC ACID

Stanley Wawzonek and D. F. Thompson

METHANESULFONIC acid is a satisfactory solvent for the study of the reduction of certain triarylcarbinols, aromatic aldehydes, and diaryl ketones at the dropping mercury electrode.

Triphenylcarbinol, tri-*p*-xenylcarbinol, tri-*p*-tertiary-butylphenylcarbinol and triphenylchloromethane, which are present as carbonium ions in this solvent, give waves with the same half-wave potentials, —0.62 volt. Aromatic aldehydes and ketones are reduced with an ease which is dependent upon the nature of the substituent present. The kinetic current observed with these compounds points to the following equilibrium in this medium.

$$R\overset{H}{C}=O + H^{+} \rightleftarrows R-\overset{H}{\underset{+}{C}}-OH$$

ABSTRACT NUMBER **73**

POLAROGRAPHY IN NONAQUEOUS SOLVENTS — THE USE OF GLYCEROL AT ELEVATED TEMPERATURES

Thos. De Vries and D. B. Bruss

THE advantages of polarography at higher temperatures are that degassing is not necessary, maxima are less frequent, and sensitivity is greatly increased. The variation of diffusion current was linear with molarity and with temperature. The half-wave potentials tended to shift to more negative values with increasing temperature and concentration. The diffusion current varied inversely as the square root of the viscosity of the solvent. Benzaldehyde, fumaric acid, meta- and para-nitrobenzoic acid, and nitrocycloheptane were reduced at the dropping mercury electrode in 0.1*M* LiCl, and with Ag-AgCl as a reference electrode. The temperature range was 70° to 120°C.

Anhydrous glycerol was not a suitable solvent

at 25°C for the polarographic determination of large molecules [Radin and de Vries, *Anal. Chem.*, **24**, 971 (1952)].

ABSTRACT NUMBER 74

THE POLAROGRAPHIC BEHAVIOR OF ZINC IN STRONGLY ALKALINE SOLUTIONS

Thedford P. Dirkse

A STUDY was made of the polarographic reduction of zinc in concentrated solutions of sodium hydroxide and potassium hydroxide. The reduction appears to take place more reversibly in potassium hydroxide solutions than in those of sodium hydroxide. Further, the reduction appears to be a step-wise process, the first step involving one electron. On the basis of this study, the nature of the zinc-containing ion in these solutions resembles the hydrogen zincate and not the zincate type, even in the most concentrated solutions.

ABSTRACT NUMBER 75

POLAROGRAPHIC DETERMINATION OF THE SYSTEM, *o*-NITROANISOLE, *o*-CHLORONITROBENZENE, AND *o*-NITROPHENOL

Shinichi Kikuchi and Kenichi Honda

IN THE synthetic process of *o*-nitroanisole (A) from *o*-chloronitrobenzene (B), it is important to analyze the product A, unreacted material B, and the nitrophenol (C) as by-product. In this paper, the application of the polarographic method to this system and the simultaneous determination of each compound in mixed solution are described.

Although polarographic studies of each of them were reported, those of their mixture have not yet been investigated. Of course, their half-wave potentials are so close to each other that it is quite difficult to get their well-defined waves separately.

As a result of the investigation in the solution

of various supporting electrolytes and various *p*H values, it was found that in strong alkaline side, the wave of C was clearly separated from those of A and B, so the determination of C became possible. The waves of A and B were still overlapped, but a slight tendency of separation was observed on the polarogram. Their separate determination could be achieved by using the residual current compensator and flowing the compensating current excessively. The polarogram, as a result of the above-mentioned method, is very abnormal, but it shows a clearer distinction of the two waves. By applying special drawing which is suitable to this abnormal polarogram, the determination of A and B became possible. As for the ratio of each compound, over the range of the mole ratio of A, B, and C from 1:1:1 to 100:5:5, respectively, the determination was possible. The precision of the determination is not yet too good, especially that of B, but it will become better by the improvement of the drawing method.

ABSTRACT NUMBER **76**

EFFECT OF STRUCTURE ON THE POLAROGRAPHIC REDUCTION OF IODO-COMPOUNDS

Eugene L. Colichman

THE polarographic properties of 29 iodo-compounds have been studied. Hammett's linear free-energy relationship is seen to permit the establishment of a quantitative relationship between structure and susceptibility to polarographic reduction of the iodo-group.

p-Fluoroiodobenzene exhibits unique polarographic behavior. A *two* step reduction is observed and a plausible explanation is offered to account for the results.

Ortho substituted iodobenzenes yield lower half-wave potentials than their corresponidng *meta* and *para* isomers. This enhancement in the ease of polarographic reduction apparently is associated with *ortho* or *proximity* effects.

Anomalous maxima suppression behavior is noted for one series of substituted iodo-compounds. Maximum suppression in the case cited yields smaller negative half-wave potentials than those obtained from the unsuppressed curves.

ELECTROTHERMICS

ABSTRACT NUMBER **77**

INERT ATMOSPHERE FORGING

Carl Kolbe

APPARATUS has been designed and operated so that a specimen will remain in argon gas during an entire heating and forging operation. A furnace capable of operating to 2500°C is coupled to a 250-lb air hammer so that refractory alloys may be forged well above their recrystallization temperature. Tungsten and molybdenum alloys have been forged at 2100°C and the surfaces have not oxidized. A three-minute 16 mm silent motion picture will show the apparatus and the forging operation.

ABSTRACT NUMBER **78**

POSSIBILITIES OF MAKING STEEL FROM ORE IN A DUPLEX ELECTRIC FURNACE OPERATION

H. S. Newhall

MORE and more people are using hot metal in the electric furnaces and for this reason it is now felt that it is perfectly feasible to make steel from ore in a two-step electric furnace operation—the first step being the reduction of ore in an electric smelter for the production of medium carbon grade of pig iron. The second step in the operation is the conversion of this medium carbon grade of pig iron to refined steel in an electric refining furnace with the means of ore, air, or oxygen.

For the double work that is going along today both in smelting and refining, this picture now seems to be much closer to being solved than at any time in the past.

ABSTRACT NUMBER **79**

FLEXIBLE LEADS FOR LOW FREQUENCY ELECTRIC ARC FURNACES

M. Eaton and S. B. Thomas

SPECIAL problems are encountered in designing cables to transfer power from the bus system to the electrodes of arc furnaces. The requirements for cable are outlined and a brief study made of the various types used. The remainder of the paper is a study of water-cooled cables with emphasis on the self-supported type. The development of this type is traced and data given on construction, current ratings, life expectancy, and other characteristics. Where possible, diagrams, pictures, and data from actual installations are included. The conclusion is that this type of cable is a practical solution of the problems encountered.

ABSTRACT NUMBER **80**

ENERGY LOSSES FROM FURNACES AND THE CONCEPT OF EFFICIENCY

Victor Paschkis

IN ORDER to compare the performance of several, or the day-to-day operations of one furnace, efficiency figures have been used; however, the concept of efficiency is insufficient because of its ambiguity. Efficiency not only varies with through-put, but for a given furnace differs according to the product made, auxiliary equipment, etc. A classification of energy losses eliminating these disadvantages is discussed (relationship between different types of losses and between each type and useful heat).

ABSTRACT NUMBER **81**

INDUCTION HEATING — DESIGN OF INDUCTORS

Anthony Vescuso

(NO ABSTRACT RECEIVED)

ABSTRACT NUMBER **82**

STATUS OF RESEARCH ON ELECTROMAGNETIC LEVITATION OF SOLID AND MOLTEN METALS

D. M. Wroughton, G. Comenetz, P. H. Brace, John C. R. Kelly, Jr., and E. C. Okress

NEW experimental data on the float-melting process are presented. These include the results of later experiments which were conducted in vacuum. A higher frequency has been investigated to test the original theory. Several formulas have been derived which permit the estimation of levitation forces on a particular metal from a knowledge of several easily determined parameters.

ABSTRACT NUMBER **83**

ARC MELTING AS A LABORATORY TOOL

H. R. Ogden and R. I. Jaffee

A SMALL hearth-type arc-melting furnace with good versatility as a research tool is described. Small button ingots of the refractory metals, the reactive metals, and the intermetallic compounds can be produced in a homogeneous condition with no contamination.

ABSTRACT NUMBER **84**

VACUUM ARC MELTING — CONTROLLING THE PURITY OF MOLYBDENUM

G. W. P. Rengstorff

MOLYBDENUM can be highly purified by repeatedly arc melting it under vacuum. The desired elements can be added to this purified molybdenum to study their individual effects on cast molybdenum. The purification method is described. Both successful and unsuccessful attempts to add specific elements without recontaminating the molybdenum are discussed.

ABSTRACT NUMBER **85**

AN APPARATUS FOR DETERMINATION OF THE SOLIDUS TEMPERATURES OF HIGH-MELTING ALLOYS

R. A. Oriani and T. S. Jones

THE reactivity of alloys of the refractory metals with crucible materials makes necessary the employment of special devices in order to determine the solidus temperatures of such alloys with any precision. In accordance with the requirements that ceramic material must not contact the specimen, and that black-body conditions must be met for the precise optical measurement of temperature, an apparatus has been constructed which permits the determination of solidus temperatures up to 2100°C. The construction, operation, and some experimental results are described.

ABSTRACT NUMBER **86**

THE USE OF RADIANT ENERGY IN HIGH TEMPERATURE, HIGH SPEED, OR CONTROLLED ATMOSPHERIC HEATING

C. F. Powell

LABORATORY applications of radiant heating for obtaining high temperatures in controlled atmosphere or for low lag heating are described.

The various aspects, advantages, and potentialities of the use of radiant energy to obtain extremely high temperatures in controlled atmosphere are discussed. Of particular interest is the potential utilization of solar energy as an abundant power source for medium and high temperature thermal chemical operations. Possible solutions of some of the difficulties which have prevented such utilization in the past are considered.

ABSTRACT NUMBER **87**

CONSTRUCTION OF MOLYBDENUM WOUND FURNACES

D. F. Taylor

MOLYBDENUM wound furnaces are useful at temperatures to 1800°C (3272°F) where the presence of hydrogen, necessary for the protection of the windings, is either required or tolerated. They are usually engineered for a specific use and require high purity components and special techniques in their construction.

Fibrous, ductile, molybdenum wire, 0.040 in. to 0.080 in., is wound externally on porous 99+ per cent alumina muffles of a desired size to form the resistor structure of the furnace. Single core furnaces vary in dimensions from 1 in. in diameter x 12 in. long to about 5 in. in diameter x 40 in. long.

ABSTRACT NUMBER **88**

HOT-PRESSING FURNACES

J. A. Upper

HOT-PRESSING operations in the temperature range of 1500°C to 2600°C at pressures of 2,000 to 10,000 psi are described. Methods of heating, the application of pressure, mold materials, temperature measurement, and insulating materials are discussed. A horizontal tubular resistance furnace and a vertical tube high-frequency hot-pressing furnace are described in some detail. Empirical curves of kw vs. furnace coil diameter and furnace coil diameter vs. diameter of molded piece are included.

ABSTRACT NUMBER **89**

ELECTRICAL CONDUCTION BY COLUMNS OF SiC GRIT

G. H. Fetterley

THIS paper is a discussion of the nonlinear relationship between voltage and current in columns of SiC grit of the type used in lightening

arresters, including equipment for the impulse testing of small samples, and some consideration of the way the total current is distributed over the apparent cross section.

ABSTRACT NUMBER **90**

THE EFFECT OF COLOR AND CRYSTAL SIZE OF SILICON CARBIDE ON THE EXPONENT CHARACTERISTICS OF VARISTOR DISKS

C. J. Frosch

THE exponent characteristics of sintered varistor disks are effected by the color and size of the silicon carbide crystals from which the grit was produced. The effects of color are shown by measurements on single particles of silicon carbide before and after firing. Varistor disks with the best exponents are obtained with grits processed from large clean crystals of dark blue silicon carbide.

ABSTRACT NUMBER **91**

THE ELECTRICAL RESISTIVITY OF HEAT-TREATED CARBON BLACKS

W. D. Schaeffer, W. R. Smith, and M. H. Polley

THE bulk electrical resistivities of several commercial carbon blacks have been determined as a function of heat treatment over the temperature range 1000°-3000°C. The changes in resistivity are qualitatively analogous to those described in the literature for solid carbons even though the maximum crystallite growth in carbon blacks occurs in the temperature range 1000°-2000°C. Effects due to the particle sizes of the carbon blacks are discussed on the basis of a close-packed system of spheres.

ABSTRACT NUMBER **92**

MOLECULAR STRUCTURE AND DIFFUSION IN AQUEOUS SOLUTION

L. G. Longsworth

WITH the adaptation of the Gouy and Rayleigh interference optical methods for the study of diffusion in solution, a precision of the order of 0.1 per cent in the coefficient is now attainable. Consequently, isomers and other structurally similar molecules can be studied with some assurance that differences found in the diffusion coefficient are due to variations in the size and shape of the diffusing entity and not to experimental error. Thus in a series of amino acids and peptides not only is the effect of chain length apparent but also such factors as branching and the presence of rings. In the amino benzoic acids the lack of resonance in the meta compound has a marked influence on the diffusion coefficient, whereas in a series of pentoses, hexoses, di- and higher saccharides a parallelism is observed between the coefficients in any one of these groups and the existence in solution of the furanose form of the sugar. The relation of the diffusion coefficient to molecular weight and volume, intrinsic viscosity, and sedimentation constant is also considered.

ABSTRACT NUMBER **93**

ACTIVITY COEFFICIENTS OF SOME SODIUM AND POTASSIUM PHOSPHATES IN REFERENCE TO BIOLOGICAL CATION CONCENTRATION GRADIENTS

Fred M. Snell

IT IS apparent that biological processes exist which produce a selective transfer of ions against concentration gradients. Such a process might involve the formation of a slightly dissociated complex of the ion to be transported which, by diffusion, crosses the cellular mem-

brane, and upon dissociation under suitable conditions would lead to accumulation. There is a considerable body of evidence which rather implicates the phosphorylated derivatives of glucose in this postulated process. Potentiometric measurements of the activity coefficients in aqueous solution of some of the sodium and potassium phosphates have been made utilizing a cell with liquid junction and incorporating a collodion cation exchange membrane. These data relating to the glucose-1-phosphates, glucose-6-phosphates, glycerophosphates, fructose-1-6-diphosphates, adenosinetriphosphates, and the inorganic pyrophosphates support the contention that these are strong electrolytes in aqueous solution and lack the requisite specificity to suggest that they are directly involved in a biological transport system which effectively distinguishes between sodium and potassium.

ABSTRACT NUMBER 94

THE GALVANIC CELL

T. Shedlovsky

THE galvanic cell, which converts the free energy of chemical reactions into electrical work, has provided a most powerful electrochemical tool for research on the theory of solutions, so important in many problems of biology and medicine. From measurements of the electromotive force of appropriate galvanic cells it is possible to determine heats of chemical reactions, transference numbers and activity coefficients of ions, ionization constants, *p*H, oxidation-reduction potentials and solubilities. The theory of the galvanic cell will be discussed with examples of applications of particular importance to biology and medicine.

ABSTRACT NUMBER 95

ELECTROCHEMICAL PHENOMENA IN PLANT CELLS

L. R. Blinks

CERTAIN large plant cells are well adapted to electrochemical studies. The magnitude of the potential difference across protoplasmic surfaces, the effects of altered ionic gradients upon these, and the control of membrane properties

by *p*H, oxygen tension, poisons, temperature, light, etc., will be described. Effects manifested under current flow (resistance, capacity, polarization, rectification, "stimulation," and recovery) have been studied, and definite values assigned to some of these (e.g., resistances up to 100,000 ohm/cm^2, capacities of 1 μF/cm^2, and counter-emf's of 200 mv).

Oxidants and reductants over a wide redox potential range have little effect upon the bioelectric potential (except for very powerful oxidants, which probably alter the membrane). However, metallic electrodes purposely introduced into the systems yield useful information. Thus voltametric (polarographic) determination of dissolved O_2 gives a sensitive measure of photosynthesis, and the redox potential of quinone, dyes, or ferricyanide indicates the reducing power of illuminated chloroplasts. Electroosmosis in plant cells appears unimportant, in physiologically possible current densities.

ABSTRACT NUMBER **96**

ELECTRICAL SIGNS OF EPILEPTIC DISCHARGE

Herbert H. Jasper

BY FAR the most dramatic and most useful application of the electroencephalogram is to the study of patients with epileptic seizures. During severe epileptic attacks the voltage of electrical activity recorded from the surface of the head may reach 10 to 20 times the voltage level of the resting activity of the brain in the same person.

Analysis of the nature of epileptic discharge by the use of microelectrodes which permit recording of the activity of individual neurones within the cortex has revealed that there are two factors involved in the electrophysiology of such activity. In the first place there is usually, but not necessarily always, an increase in the voltage of the relatively slow waves of the cortex comparable to what is commonly known as "brain waves." This seems to be due not only to a larger number of elements beating in unison but also to a higher voltage generated in each of the elements producing the slow wave phenomenon. These slow waves are generated in the fine fibrils and synapse of the cortex independent of actual discharge in cortical neurones. In epileptic seizures the frequency of discharge of in-

dividual neurones may increase to 600-800 per second for relatively short intervals of time. In addition there are many more simultaneously active units in the cortex so that the excessive discharge of epilepsy must be considered to represent an increase in the synaptic potentials of the cortex in most cases, although not all, but primarily an increase in the frequency of discharge of individual neurones and in the number of neurones simultaneously active throughout the depths of the cortex. The most important contribution to our understanding of epilepsy will come when the biochemical changes causing heightened excitability and excessive discharge of cortical cells in epileptic patients is discovered.

ABSTRACT NUMBER **97**

ELECTROENCEPHALOGRAPHIC LOCALIZATION OF BRAIN TUMORS

B. K. Bagchi

ALTHOUGH pulsating electrical potentials of the brain have been, in the last 15 years, a subject of a wide variety of experimental investigations the fundamental physicochemical mechanism of their origin is still not clear. It is known, however, that the recorded waves are due to the spatial and temporal summation of the discharges of individual nerve cells of the brain and that they undergo changes concurrently with changes in normal or abnormal cerebral physiology. The presence of a brain tumor may cause focal and diffuse changes in brain potentials. Empirical interpretation of such changes helps to localize tumors near the upper convexity of the brain 75 to 90 per cent of the time. This nontraumatic diagnostic electroencephalographic procedure has recently been a most important aid to neurosurgeons and neurologists in their understanding of some diseases of the central nervous system.

ABSTRACT NUMBER **98**

REVIEW OF ELECTROPHORESIS INTO THE HUMAN SKIN

Harold A. Abramson

THE electrophoretic introduction into the skin of metallic salts, anesthetics, dyestuffs, hista-

mine, allergens like ragweed, and epinephrine will be reviewed in connection with two physiological problems: (*a*) the route and mechanism of introduction; and (*b*) application to therapy of hay fever, asthma, and multiple sclerosis.

ABSTRACT NUMBER 99

SOME PROBLEMS ARISING IN THE CLINICAL INTERPRETATION OF ELECTROCARDIOGRAMS

Franklin D. Johnston

THE character of the electrical phenomena to be recorded in connection with electrocardiograms will be pointed out and instrumental inadequacies and technical difficulties or mistakes that may lead to faulty interpretation will be discussed. The common types of leading systems employed will be described briefly and their meaning, in terms of electrical events in the heart and how they help in diagnosis of cardiac abnormalities, outlined. Some of the difficulties in the use of these leads, including those employed to obtain spatial vectorcardiograms, and suggestions for leads that may be superior to those in current use will be presented.

ABSTRACT NUMBER 100

MEMBRANE POTENTIALS IN THE DONNAN EQUILIBRIUM, II

David I. Hitchcock and Alexander Mauro

THE Donnan membrane potential in a gelatin-HCl system, as measured by Loeb's method with the aid of calomel electrodes in saturated KCl, is not abolished by making a hole in the membrane. This was confirmed as follows. After equilibrium was established, a silver-silver chloride electrode was placed directly in each solution. The electromotive force measured across the intact membrane was zero. Each solution with its electrode was then removed from the membrane and placed in an Ostwald electrode vessel. The side arms of both vessels were dipped into a beaker containing a portion of one of the solutions. The electromotive force was still zero, and remained zero after 18 hours for free diffusion at the liquid junction. When the side

arms were connected by saturated KCl, an electromotive force equal and opposite to the Donnan membrane potential was observed.

If the single potential difference across the membrane has any physical reality, it must be in this case equal to a Nernst diffusion potential, since the electromotive force of neither of the actual cells is affected by the removal of the membrane. Such experiments may have a bearing on the explanation of bioelectric potentials.

ABSTRACT NUMBER **101**

MEMBRANES, THEIR ELECTROCHEMISTRY, AND THEIR USE IN MODEL STUDIES OF BIOLOGICAL INTEREST

Karl Sollner, Sheldon Dray, Eugene Grim, and Rex Neihof

THE following subjects are considered: Membranes of porous character. Concentration potentials. Electronegative, acidic membranes preferentially permeable to cations, electropositive, basic membranes to anions. Preparation of membranes of highest electrochemical activity. Membranes of ideal or nearly ideal ionic selectivity, "permselective" membranes.

Heteroporosity. Anomalous osmosis; its theory. Transportation of liquid by anomalous osmosis at physiological concentration levels as rapid as transportation rates across the gut, etc.

Concentration potentials across permselective membranes. Permselective membranes as membrane electrodes for the determination of activity of numerous anions and cations. Membrane electrodes in protein chemistry. Permselective membranes in electrodialysis. Donnan equilibria. Systems drifting toward Donnan equilibria and a possible dynamic mechanism for ion accumulation *in vivo*.

Mosaic membranes composed of ideally anion and ideally cation selective parts; quantitative data proving their theory. Mosaic systems and accumulation of electrolytes *in vivo*.

Polyionic potentials across membranes of ideal ionic selectivity. Theory of bi-ionic potential extended to polyionic systems. Their importance in electrophysiology.

ABSTRACT NUMBER **102**

ON THE NATURE OF THE MEMBRANE POTENTIAL OF FROG NERVE

R. Lorente de Nó

ACCORDING to the classical hypothesis, the resting membrane potential of frog nerve is maintained by the diffusion of potassium ions across the nerve membrane. For this reason the value of the membrane potential should be proportional to the logarithm of the ratio of the concentrations of potassium inside and outside the nerve fibers. It has appeared, however, that the membrane potential can be maintained in the presence of very large outside concentrations of potassium. On the other hand, evidence is available to show that the membrane potential is directly dependent upon oxidative metabolism. It is believed that this metabolism results in the establishment of electric double layers in the nerve membrane by an, as yet, unknown mechanism.

ABSTRACT NUMBER **103**

DYNAMIC NEGATIVE RESISTANCE IN STATICALLY STABLE MEMBRANES

Otto H. Schmitt

TRANSIENT charges in the a-c conductance of thin membranes polarized with varying d-c currents are difficult to measure because of the masking effects of static membrane capacitance. This masking can be eliminated by cancelling the static membrane capacitance with electronically generated negative capacitance. An oscillographic method based on this principle has been developed which displays conductance plotted instantaneously against d-c polarizing current while this current is varied through a triangular wave-time sequence of adjustable duration. Under suitable ionic conditions both natural biological membranes and synthetic membranes have been made to display dynamic negative resistance characteristics somewhat similar to those postulated for excitable biological tissues like nerve or muscle.

ABSTRACT NUMBER **104**

THE IMPLEMENTATION OF ELECTRICAL ENERGY BY PAIRED HALF-CENTERS AS REVEALED BY STRUCTURE AND FUNCTION

Robert Gesell

A SYSTEM of nervous integration is outlined based on a specialization of structure and function of the nerve cell: (*a*) for generation of neurocellular currents by the dendrites and cell body; (*b*) for periodic generation of nerve impulses by the neuromembrane of the axon hillock in response to neurocellular currents; (*c*) for transmission of impulses from axon hillock to end bouton by the neuraxon; (*d*) for implementation of the nerve impulses by the end bouton; (*e*) for inhibition of nerve cell activity by control of polar potentials (synaptic negativities imposed on the axon hillock).

It is tentatively proposed that nerve cells are arranged in the general plan of paired half-centers as originally proposed by T. Graham Brown, for the higher as well as for the lower forms of nervous activity.

Theoretical explanations are offered for: (*a*) generation of neurocellular currents; (*b*) neurocellular generation of nerve impulses; (*c*) neurocellular inhibition; (*d*) after discharge; (*e*) automatic rhythm; (*f*) motor activity pattern; (*g*) reciprocal inhibition; and (*h*) rebound.

ABSTRACT NUMBER **105**

THE EFFECTS OF CHANGES IN THE INTERNAL COMPOSITION OF THE SINGLE NERVE FIBER ON THE BIOELECTRIC POTENTIAL

Harry Grundfest

ELECTROGENIC tissues (nerve, muscle, electric organ) contain complex electrochemical systems, operating differently during rest or activity of the units. At rest, the interiors of the individual cells are negative to the external phase. The resting potential has been ascribed to differences in ionic composition between the interior and exterior of the cells, maintained by metabolic processes and by a metabolically con-

ditioned boundary phase or excitable membrane. Alteration of the ionic content of the external medium produces changes in the resting potential which are explainable on the basis of simple physicochemical dynamics. Large local increases of the internal concentrations of K^+, Na^+, or Cl^- by means of microinjection into giant nerve fibers do not produce resting potential changes expected on the basis of these dynamics. It is possible, therefore, that the excitable membrane is more complex than hitherto suspected and that it has different properties at its interior and exterior phases. Further support for this view is supplied by study of the electrical phenomena during the activity of the injected nerve fibers. During activity, a local region of the fiber is electrically altered, the interior of this region becoming less negative than the exterior of the same region. This phenomenon may be satisfactorily correlated with a series of changes in the excitable membrane with which are associated temporary specific redistributions in flux of the different ions as determined by conductance measurements. Experimental alterations of the internal ionic environment do not, however, produce results to be expected on this basis. The finding that extraordinarily small amounts of injected Mg^{++} are capable of affecting nerve function as strongly as 10^5 times as much K^+ indicates that the electrochemical system of the nerve fiber is associated with a specific structural configuration of the excitable membrane. In agreement with this are findings that the complex molecules of a variety of drugs affect nerve function more or less powerfully in correlation with their molecular configurations and charge distributions.

ABSTRACT NUMBER **106**

IONS, POTENTIALS, AND THE NERVE IMPULSE

Kenneth S. Cole

THE recent powerful exploitation of the squid giant nerve fiber has given an explanation of the propagation of the nerve impulse in terms of sodium and potassium ions crossing the membrane at the surface of the fiber under the control of the membrane potential difference. The potential and the ion movements allow a rapid reversal and recovery of the potential to be propagated at the cost of an intake of sodium

ions and a loss of potassium ions by the fiber. The mechanisms of the ion flow controls and the ultimate re-exchange of the ions are yet to be explained.

ABSTRACT NUMBER **107**

THE MOLECULAR BASIS OF NERVE ACTION POTENTIALS

David Nachmansohn

IONIC concentration gradients between the inside of the nerve fiber and its outer environment are the primary source of energy of nerve action potentials. Sodium is more concentrated on the outside; the reverse is true for potassium. There is a continuous slow movement of ions in rest in both directions. During activity, however, there is a sudden influx of sodium ions from the outside and an equivalent leak of potassium ions due to increased permeability of a still hypothetical but generally postulated membrane separating the inside of the axon from the outside. The central problem of generation of electric currents in nerve fibers and, therefore, the crucial problem of nerve function is the question of the mechanism by which the change in permeability is produced, making the potential source of energy effective.

During the last 15 years a large body of evidence has accumulated indicating that the release of acetylcholine is responsible for the primary alterations of the membrane during activity. This trigger action of acetylcholine making the energy of the ionic concentration gradients available is apparently due to the effect of the ester upon a receptor protein. An enzyme, acetylcholinesterase, inactivates the free ester and thus enables the receptor protein to return to its resting condition. This reaction proceeds at the speed postulated on the basis of electrical recordings. The essentiality of this reaction has been demonstrated, the sequence of energy transformations associated with the action potential has been established, and acetylcholine has been integrated into the metabolic cycle of the nerve cell. The problem has been advanced to the molecular level. The molecular force acting between protein and acetylcholine will be discussed.

ABSTRACT NUMBER **108**

LIGHT SCATTERING STUDIES ON KINETIC AND EQUILIBRIUM RELATIONS IN THE FORMATION OF MERCAPT-ALBUMIN MERCURY DIMER

John T. Edsall, Ephraim Katchalski, and Robert H. Maybury

THE kinetics of the formation and dissociation of mercaptalbumin mercury dimer have been studied as functions of *p*H, ionic strength, temperature, and other variables. Mercaptalbumin (ASH) reacts with mercuric salts (HgX_2) through its sulfhydryl group to give the derivative ASHgX, and this combines with a second molecule of ASH to form the dimer ASHgSA.

$$\text{ASHgX} + \text{ASH} \underset{k_{-2}}{\overset{k_2}{\rightleftharpoons}} \text{ASHgSA} + \text{H}^+ + \text{X}^-$$

Evidence will be presented that the reaction is truly reversible. The velocity constant k_2 falls from 40 l mole^{-1} min^{-1} at *p*H 4.75 to 0.7 l mole^{-1} min^{-1} at *p*H 6, the net charge on the molecule of ASH varying from zero to approximately -10 over this range. The binding by the protein of certain fatty acid anions, at *p*H near 4.75, has a significant effect in accelerating the reaction rate, and also shifts the equilibrium in the direction of increased dimer formation. The temperature coefficient of k_2 is large, corresponding to an energy of activation near 18 kcal/mole.

The dissociation of the dimer is accelerated by the presence of halide ions, their effect decreasing in the order $I^- >> Br^- >> Cl^-$. The addition of these ions also shifts the equilibrium in the direction of dissociation of the dimer, iodide being by far the most effective. The mechanism of the observed effects will be discussed.

ABSTRACT NUMBER **109**

ION EXCHANGER ELECTRODES

George Scatchard

ION exchanger membranes may serve as useful models of electrically charged membranes in biological systems. They will certainly be useful

as "electrodes" for the measurement of activities of small ions without introducing any disturbances from oxidation or reduction. These electrodes are selective to cations or to anions over a considerable concentration range. This selectivity is not due to slowing down ions of the same sign as the membrane, but is due to reducing their concentration within the membrane. The membranes have very little specificity for different ions of the opposite charge, except that very large ions are excluded by a sieve effect. These properties make the combination of a cation exchanger membrane and an anion exchanger membrane a very useful tool for the study of the interaction of small ions with proteins and other macromolecules. The Meyer-Sievers method of calculating selectivity and capacity of a charged membrane from electromotive force measurements is seriously in error because of the neglect of the effect of the transference of water.

ABSTRACT NUMBER **110**

THE DETERMINATION OF THE ACTIVITY OF SMALL IONS IN PROTEIN SOLUTIONS WITH COLLODION MEMBRANE ELECTRODES

Charles W. Carr

THE activity of small ions in protein solutions is determined by making potential measurements across specially prepared collodion membranes. Membranes impregnated with sulfonated polystyrene are used for cation activity measurements, and membranes impregnated with protamine are used for anion activity measurements. The activity of chloride, thiocyanate, sodium, potassium, calcium, and magnesium ions has been determined in solutions of such proteins as serum albumin, serum globulins, egg albumin, casein, β-lactoglobulin, hemoglobin, pepsin, and lysozyme. Where comparison has been possible, the results are in agreement with other methods of measurement.

ABSTRACT NUMBER 111

HYDROGEN ION TITRATION CURVES OF PROTEINS

Charles Tanford

PROTEIN molecules play a decisive role in virtually every biological and medical phenomenon, acting as muscle fibers, oxygen carriers, enzymes, antibodies, genes, etc. The ability of these molecules to carry out their diverse functions must lie largely in the reactive groups on the side-chains of the molecules.

Hydrogen ion titration curves, as determined from emf measurements with hydrogen or glass electrodes, make possible estimation of the number of side-chain groups of various types on a protein molecule. Such curves have shown that in some proteins certain side-chain groups are masked over a certain *p*H range, but irreversibly released outside that range. For many proteins values of ionization constants and heats and entropies of ionization have been obtained, yielding information on hydrogen-bonding or other weak interactions of the side-chain groups.

Two recent innovations are the study of the slopes of titration curves to yield information on the shapes of protein molecules and their alteration with *p*H, and the determination of titration curves in the presence of metals to obtain data on metal-binding by the side-chain groups.

ABSTRACT NUMBER 112

SOME ASPECTS OF BIOELECTRICAL PHENOMENA

W. J. V. Osterhout

BIOELECTRICAL effects appear to be due to diffusion potentials. The "all-or-none" law states that the response to electrical stimulation is always complete but we find in *Nitella* what appear to be partial responses.

These may be explained on the ground that the resting potential, P, is the sum of two partial potentials, one of which, P_X, is at the outer protoplasmic surface and the other, P_Y, is at the inner protoplasmic surface. P_Y may disappear without affecting P_X. The response is therefore complete for P_Y. The potential at each surface appears to obey the all-or-none law.

ABSTRACT NUMBER **113**

CHEMICAL SPECIFICITY IN BIOLOGICAL INTERACTIONS

Edwin J. Cohn, Douglas M. Surgenor, Frank R. N. Gurd, Margaret J. Hunter, and Walter L. Hughes, Jr.

AS A consequence of the dipolar ionic structure of amino acids, peptides, and proteins, electrochemical interactions in biological systems exhibit a high degree of specificity. Since the dielectric constants of oriented dipole molecules may be high, ". . . Coulomb forces are reduced and conditions obtain that differ widely even from those characteristic of dilute aqueous electrolyte solutions . . ." and "the principle of ionic strength no longer determines behavior." Deviations from ideality characteristic of strong electrolyte solutions become less important than steric effects which permit or hinder complex formation. "Under these conditions the behavior of glycine is readily distinguished from that of alanine, and of sodium from that of potassium."

The rigidity of serum albumin depends upon the cross-linking of neighboring segments of the peptide chain, as a result of strong electrostatic attraction between guanidine and phenolic hydroxyl, imidazole and Aspartyl β-carboxyl, ε-amino of Lysyl, and the γ-carboxyl of Glutamyl residues. The difference in the dissociation constants of these cross-linked residues is far smaller than that between the constants of the α-amino and carboxyl groups in the peptide chain. The three strongest links in the peptide chain appear to be between alanyl and seryl, threonyl and Leucyl, and valyl and phenylalanyl residues. Among the feeblest are those between alanyl and Tyrosyl, prolyl and Aspartyl, and Lysyl and phenylalanyl residues. Basic and polar substituents alter the acidity of both acid and basic groups.

Calcium and magnesium, iron, copper, mercury, and zinc complex with different association constants to specific configurations of amino acid residues: zinc with imidazole and Cystyl residues in undenatured human serum albumin: mercury with these and Arginyl residues.

Unlike the single sulfur atom of Cysteine and reduced glutathione, the paired sulfur atoms of Cystyl residues dissociate a proton from the ammonium group. Oxidation and reduction thus change the basic dissociation constants of these sulfur-containing amino acids in the physiological *p*H range.

The three interlocking processes upon which chemical differentiation of proteins appears to depend are: (*a*) oxidation and reduction between Cystine and Cysteine, between Tyrosine and phenylalanine, and between proline and glutamine, or Glutamic acid and ornithine; (*b*) transamidation between glutamine and asparagine; and (*c*) transmethylation between serine and methionine, Cysteine and threonine, and certain other residues.

It is significant that the concentration in plasma of dicarboxylic amino acids, free or in peptides, is extraordinarily low; that the amino acid present in highest concentration is glutamine, and that the amino acid of most constant concentration is proline.

ABSTRACT NUMBER 114

POLAROGRAPHIC STUDY OF PROTEINS AND THEIR DEGRADATION PRODUCTS

IV. The Behavior of Various Fractions of Plasma Proteins

Otto H. Müller

IN ORDER to get some definite information on the interrelation between the previously described polarographic digest and filtrate tests of plasma, the various available human plasma fractions have been studied by themselves. It was found that the digest test represents mainly the albumin component of plasma while the filtrate test is largely determined by the α- and β-globulins present. γ-globulin apparently does not contribute to the latter test. It could further be shown that the substances (polypeptides) responsible for the filtrate test are not present to a great extent in a free form but must be liberated by mild alkaline digestion from a larger complex.

ABSTRACT NUMBER 115

DIELECTRIC STUDIES IN CONCENTRATED PROTEIN SOLUTIONS

J. L. Oncley and H. M. Dintzis

WE HAVE recently completed measurements of dielectric constant, ϵ, and specific conduct-

ance, H, as functions of frequency, ν, and protein concentration, g, for solutions of human serum mercaptalbumin. The concentration range extends from 3 to 84 g/l. Similar measurements have been reported for β-lactoglobulin by Shaw, Jensen, and Lineweaver (g from 3 to 94 g/l) and by Ferry and Oncley (g from 1 to 9 g/l). At low protein concentration the quantities $(\epsilon - \epsilon_\infty)/(\epsilon_0 - \epsilon_\infty)$ and $(H - H_0)/(H_\infty - H_0)$ depend upon the frequency, ν, as demanded by the theory of Perrin for the behavior of rigid elongated ellipsoids of revolution. As the protein concentration increases, however, these quantities change rather rapidly.

The interactions which cause these changes in the dispersion behavior at high protein concentrations have been interpreted by evaluation of a distribution of relaxation times consistent with the observed results. It is observed that the relaxation time due to rotation around the long axis changes little, while that due to rotation around the short axis increases considerably and becomes a rather wide distribution of times. Such an interpretation seems reasonable, since rotation of an elongated ellipsoid of revolution around the long axis causes little interference with neighboring molecules, while rotation around the short axis will interfere with many neighbors, even in relatively dilute solution.

These measurements lead to interesting conclusions when we apply the so-called circle diagrams of Cole (plots of $\Delta\epsilon$ vs. $\Delta\epsilon'' = 1.80 \times 10^{12} \Delta H/\nu$). The parameter α of the circle diagram then depends upon the ratio of the two relaxation times observed in very dilute solution, and upon the amount of interaction observed in these systems.

This interpretation seems to be in good agreement with other studies involving measurements of number- and weight-average molecular weight, sedimentation and diffusion constants, and viscosity coefficient.

ABSTRACT NUMBER 116

A DEMONSTRATION OF THE LILLIE IRON WIRE NERVE CONDUCTION MODEL

R. L. Taylor, D. R. Turner, and H. M. Straube

A MOTION PICTURE will be shown of experiments with the Lillie iron wire nerve conduction model. The nerve model is excited with a cathodic pulse and the progress of the result-

ing impulse traveling along the iron wire is observed on a cathode ray oscillograph screen. Factors effecting the rate of impulse travel are discussed.

THEORETICAL ELECTROCHEMISTRY

GENERAL THEORETICAL

ABSTRACT NUMBER 117

KINETICS OF LAYER FORMATION ON COPPER ANODES IN HCl AND KCl SOLUTIONS

J. H. Bartlett and Lee Stephenson

FOR high currents and very small external resistance R, the layer (cuprous chloride?) on a copper anode in HCl solution is completed very rapidly, and the current drop is represented by the equation $\frac{dr}{dt} = k_1 i - k_2$, where r is the layer resistance, i is the current, and k_1 and k_2 are constants.

Growth of the layer probably occurs on the metal side because (*a*) the charge ($\int i\,dt$) to form complete layer is proportional to $\tau^{1/2}$ and (*b*) oscillations occur only when $R \geq r$.

ABSTRACT NUMBER 118

AN OPTICAL METHOD (SCHLIEREN) FOR THE QUANTITATIVE INVESTIGATION OF DIFFUSION LAYERS

Lee Stephenson

A SCHLIEREN system has been built, by means of which the refractive index of the electrolyte in a diffusion layer can be determined quantitatively as a function of time and of position within the diffusion layer. If one knows the dependence of refractive index upon concentration, the Schlieren results can be used to obtain the concentration distribution within the diffusion layer.

The above apparatus has a resolving power of about .01 mm, and is inexpensive to construct. A discussion will be given of the accuracy, sensitivity, and applications of the method.

ABSTRACT NUMBER **119**

ELECTROCHEMICAL POLARIZATION OF ZIRCONIUM IN SODIUM CHLORIDE SOLUTION

Norman Hackerman and Olin B. Cecil

CATHODIC and anodic polarization curves of zirconium in neutral sodium chloride solutions were determined at constant current densities in the range 3.5×10^{-5} to 3.5×10^{-3} amp/cm^2. The cathodic polarization curve is characterized by the oxygen diffusion limiting current wave occurring at 2×10^{-4} amp/cm^2 and another wave occurring at a current density of 2×10^{-6} amp/cm^2. Anodically zirconium dissolves in neutral sodium chloride solutions at all current densities studied but is passive in neutral sodium sulfate solutions.

ABSTRACT NUMBER **120**

STRUCTURAL FEATURES OF OXIDE COATINGS ON ALUMINUM

F. Keller, M. S. Hunter, and D. L. Robinson

ANODIC oxide coatings on aluminum are shown by electron micrographs to consist of close packed hexagonal cells of oxide, each of which contains a single pore. Methods are described for determining the size of the cells and pores and the thickness of the cell walls. The microdimensions of coatings formed in sulfuric acid, phosphoric acid, chromic acid and oxalic acid electrolytes are given and the effect of the electrolyte and forming voltage on cell and pore dimensions are demonstrated. The relationship

between these dimensions and the characteristics and behavior of anodic oxide coatings are discussed.

ABSTRACT NUMBER 121

EXPERIMENTAL STUDY OF 'POTENTIAL-*p*H-RATE OF CORROSION' DIAGRAMS

Paul Delahay, George L. Stiehl, John A. Perry, and Talivaldis Berzins

THIS paper deals with an investigation of the anodic oxidation of metals at constant potential and at controlled *p*H. General criteria for the study of the anodic oxidation of metals are derived from an approximate kinetic treatment, and the corresponding experimental methods are briefly discussed. Examples of curves showing the variations of the rate of corrosion with potential are presented and discussed for the case of iron. The complete experimental study is summarized in a potential-*p*H diagram showing lines of equal corrosion rates. Such diagrams are presented for three metals (iron, lead, and tin) and discrepancies with equilibrium diagrams are interpreted.

ABSTRACT NUMBER 122

ELECTROLYSIS AT CONSTANT CURRENT

Paul Delahay and Talivaldis Berzins

AN ANALYSIS is made for various types of potential time curves ("reversible" and irreversible electrochemical reactions, kinetic and catalytic electrode processes) which are obtained in electrolysis at constant current with mass transfer partially or totally controlled by semi-infinite linear diffusion. The principle of this recently revived method and the work of previous investigators are also briefly reviewed. Various applications in the fields of electrochemistry and kinetics are discussed.

ABSTRACT NUMBER **123**

THE ACID DISSOCIATION OF THE AQUOSCANDIUM IONS

II. Effect of Temperature and of Ionic Strength

Martin Kilpatrick and Lewis Pokras*

THE first dissociation constant of hexaaquoscandium ion and the dimerization constant for the hydroxylpentaaquoscandium ion have been determined in the solvent salt sodium perchlorate over the temperature range 10 - 40°C. From these data, approximate values of $\triangle H$ and $\triangle S$ have been calculated. The effect of electrolyte concentration on the above equilibrium constants is also reported.

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ABSTRACT NUMBER **124**

CATION EXCHANGE PROCESS FOR THE PREPARATION OF POTASSIUM CYANIDE

C. H. Lemke

EQUILIBRIUM data are presented for the reactions of: Na + KCN, KCl + NaCN and KOH + NaCN in the fused state. The latter two reactions were effected by a new "alloy bridge" technique which does not require direct contact of the reactant salts. In this manner, potassium cyanide was obtained substantially free of anions other than CN^-. Reaction rate data are presented for the reaction of KCl + NaCN by the "alloy bridge" method, and other possible applications of the method are suggested.

ABSTRACT NUMBER **125**

THE PREPARATION AND ELECTROCHEMICAL PROPERTIES OF IRON AND COBALT PHOSPHIDES

Donald W. Wood, John C. Bailar, Jr., Herbert A. Laitinen, and Sherlock Swann, Jr.

THE iron phosphides, Fe_3P, Fe_2P, FeP, and FeP_2, were prepared by fused-salt electrolysis

of a phosphate bath containing iron oxide and sodium fluoride. A similar procedure was used for the preparation of CoP.

The rates of corrosion of Fe_2P, FeP, and CoP in the common acids and bases were determined, as well as their anodic and cathodic behavior in various acids, bases, and salts. Electrical resistivity measurements were made of sintered compacts of Fe_2P, FeP, and CoP.

ABSTRACT NUMBER 126

EQUIVALENT-CIRCUIT MODEL OF THE TRANSFERENCE CELL

George W. Murphy*

AN equivalent-circuit model is proposed for a cell with reversible electrodes in contact with a solution of a suitable binary electrolyte, nonuniform in concentration. The capacitance part of the circuit is related to the free energy change of the dilution process, while the resistance parts are related to the cation and anion transports. The model leads directly to familiar equations and suggest a new technique of cell measurement for deriving thermodynamic properties.

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ABSTRACT NUMBER 127

CURRENT DISTRIBUTION OVER ELECTRODES OF FINITE CONDUCTIVITY

Charles W. Tobias and Robert A. Wijsman

THE effect of ohmic potential drop on current distribution in thin sheet electrodes has been subjected to mathematical analysis. Exact solutions have been obtained for the current distribution in terms of dimensionless parameters. The combined effects of cell dimensions, electrode-electrolyte conductivity ratio, and linear polarization are evaluated. The limits of validity of simplifying approximations are indicated.

ABSTRACT NUMBER **128**

POLARIZATION MEASUREMENTS WITH THE OXYGEN ELECTRODE*

R. R. Witherspoon, Ernest Yeager, Herman Urbach, and Frank Hovorka

CATHODIC polarization measurements have been made by the commutator technique with air-cell carbon in alkaline solutions. These measurements indicate that, even at appreciable current densities, the electrochemical conversion of adsorbed oxygen to the perhydroxide ion is essentially reversible. The rate-determining steps are primarily associated with the conversion of gas-phase oxygen to adsorbed oxygen and the removal of excess perhydroxide ions from the solution-electrode interface through diffusion, electrolytic transport, and/or decomposition.

*Work partially supported by the Office of Naval Research.

ABSTRACT NUMBER **129**

IONIC VIBRATION POTENTIALS*

Ernest Yeager, Harry Dietrick, Frank Saunders, and Frank Hovorka

WHEN ultrasonic waves are introduced into an electrolytic solution, alternating potentials are developed within the solution. The effect depends on differences in the masses and mobilities of the ions and can be used to determine the relative ionic hydration numbers. A mathematical discussion of the effect will be presented and the results thereof compared with experimental data obtained with pulse-modulated ultrasonic waves at a frequency of 200 kc/sec.

*Work partially supported by the Office of Naval Research.

ABSTRACT NUMBER **130**

ON THE ELECTROCHEMISTRY OF ION-EXCHANGE RESINS

K. S. Spiegler*

ELECTROCHEMICAL properties of ion-exchange resins such as specific conductances, ionic mobilities in the resins, and potentials across resinous membranes have been measured recently. A review of these measurements and their correlation to the general thermodynamic treatment of ion-exchange resins is presented. Applications such as the use of resinous membranes as ionic sieves, electrolytic regeneration of ion-exchange resins, and the use of ion-exchange resins as media for electrophoretic separations are discussed.

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ABSTRACT NUMBER **131**

APPARATUS FOR STUDYING ELECTROGRAVITATIONAL SEPARATIONS: SOME EXPERIMENTS ON THE EXTRACTION OF SODIUM CHLORIDE FROM SOLUTION IN A FLOW SYSTEM

George W. Murphy and David Batzer*

AS THE first step in a systematic experimental investigation of an electrogravitational method for separating simple electrolytes, new apparatus of great versatility has been constructed and experiments on the removal of NaCl in a flow system have been performed. The power supply is designed to furnish up to 50 amperes to the experimental cell at potentials of 0.7 volt or less, controlled electromechanically to $\pm\frac{1}{2}$ per cent. Solution passes upward through a narrow rectangular channel formed by silver-silver chloride electrodes, and then out through a miniature conductance cell. The voltage is maintained constant during an experiment, and current is passed until the active electrode material is exhausted. Effluent conductances, as well as

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voltages and currents, are monitored continuously by recording equipment. Qualitatively, conductance-time curves resemble the "breakthrough" curves of certain ion exchange experiments. These curves were obtained for concentrations between 0.05 to 0.5*N* NaCl, and flow rates from 2.5 to 15 ml/hr. Separation factors and current efficiencies are reported.

ABSTRACT NUMBER **132**

STABILIZATION OF THE DIVALENT STATE OF SILVER THROUGH COORDINATION

A. L. McClelland, J. C. Bailar, Jr., and H. A. Laitinen

QUANTITATIVE determinations have been made of the stabilities and compositions of the complex ions formed by divalent silver with pyridine, dipyridyl, and 1,10 phenanthroline. Formulas of the ions were determined from the variation in oxidation-reduction potential of the Ag(I)-Ag(II) couple produced by changes in the concentration of the complexing agent; the stability was calculated from the differences between the standard potentials of the couple in the complexed and uncomplexed states. The pyridine complexes decompose slowly in solution; the kinetics of the decomposition have been investigated. The dipyridyl and phenanthroline complexes are stable in solution.

ABSTRACT NUMBER **133**

RATE OF DISPLACEMENT OF SILVER FROM AQUEOUS SOLUTIONS OF SILVER NITRATE BY ZINC AND COPPER

Richard Glicksman,* Henri Mouquin, and Cecil V. King

SILVER is displaced at a faster rate than one would expect for diffusion-controlled reactions. The high rates are attributed to local cell action caused by the plating of silver on the zinc and copper.

The rates were measured under varying conditions of concentration, viscosity, conductivity,

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temperature, rotational speeds, and applied potentials. At very low concentrations using radioactive silver - 110 as a tracer, rates approached values calculated for diffusion control.

ABSTRACT NUMBER 134

EFFECT OF STRESS ON METAL ELECTRODE POTENTIALS*

Robert E. Fryxell** and Norman H. Nachtrieb

THE effect of stress on the electrode potentials of silver and gold has been measured. Tension renders these metals cathodic in aqueous solutions of their corresponding salts. Compression produces changes in the opposite direction. These changes are proportional to the applied load. Quinhydrone and ferrous-ferric electrodes are not affected by stress.

The observations cannot be accounted for on the basis of thermodynamic changes produced within the metal. Necessarily, a surface phenomenon is responsible. The condition of the metallic surface is shown to be an important variable, though studies of certain variables within the electrolyte have failed to reveal the nature of polarization.

*Contribution from the University of Chicago.
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ABSTRACT NUMBER 135

ELECTROCHEMICAL PROPERTIES OF DILUTE SODIUM AMALGAMS*

Harry Dietrick, Ernest Yeager, and Frank Hovorka

ANODIC polarization measurements, corrosion measurements, and activity measurements have been made for dilute sodium amalgams in various sodium hydroxide solutions. In well-stirred solutions the anodic polarization as determined by the commutator method is less than 2 mv for current densities as high as 1 amp/cm². Corrosion rates for amalgams of the order of 3 per cent or less by mole-fraction are almost negligible in sodium hydroxide solutions.

*Work partially sponsored by the Office of Naval Research.

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OCEAN TERRACE HOTEL

Wrightsville Beach, N. C.

September 13, 14, 15, 16, and 17, 1953

SESSIONS ON

Battery

Corrosion

Electrodeposition

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